6. BIOLOGICAL OVERVIEW

Factors 3 and 4 of the 10 factors used to determine unreasonable degradation under the Ocean Discharge Criteria regulations call for the assessment of the biological communities which may be exposed to pollutants, the presence of endangered species, any unique species or communities of species, and the importance of the receiving water to the surrounding biological communities. This chapter describes the biological community of the eastern Gulf of Mexico. The species identified as threatened or endangered by the USFWS and NMFS are characterized in the last section of this chapter for compliance with Section 7 of the Endangered Species Act..

6.1 Primary Productivity

Primary productivity is "the rate at which radiant energy is stored by photosynthetic and chemosynthetic activity of producer organisms in the form of organic substances which can be used as food materials" (Odum, 1971). Primary productivity is affected by light, nutrients, and zooplankton grazing, as well as other interacting forces such as currents, diffusion, and upwelling.

The producer organisms in the marine environment consist primarily of phytoplankton and benthic macrophytes. Since benthic macrophytes are depth/light limited, primary productivity in the open ocean is attributable primarily to phytoplankton. The productivity of nearshore waters can be attributed to benthic macrophytes--including seagrasses, mangroves, salt marsh grasses, and seaweeds--and phytoplankton.

There are numerous methods for estimating primary productivity in marine waters. One method is to measure chlorophyll content per volume of seawater and compare results over time to establish a productivity rate. The chlorophyll measurement, typically of chlorophyll a, gives a direct reading of total plant biomass. Chlorophyll a is generally used because it is considered the "active" pigment in carbon fixation (Steidinger and Williams, 1970). Another method, the C^{14} (radiocarbon) method, measures photosynthesis (a controversy exists as to whether "net", "gross", or "intermediate" photosynthesis is measured by this method; Kennish, 1989). The C^{14} method introduces radiolabeled carbon into a sample and estimates the rate of carbon fixation by measuring the sample's radioactivity.

The units used to express primary productivity are grams of carbon produced in a column of water intersecting one square meter of sea surface per day (g $C/m^2/d$), or grams of carbon produced in a given cubic meter per day (g $C/m^3/d$).

C^{14} uptake throughout the Gulf is 0.25 g $C/m^3/hr$ or less, and chlorophyll measurements range from 0.05 to 0.30 mg/m^3 (ppb). Eastern regions of the Gulf of Mexico are generally less productive than western regions, and throughout the eastern Gulf, primary productivity is generally low. However, outbreaks of "red-tide" caused by pathogenic phytoplankton may occur in the mid- to inner-shelf. Also, depth-integrated productivity values in the area of the Loop Current (primarily the outer shelf and slope) are actually higher than western and central Gulf values. Enhanced productivity occurs in areas affected by upwelling. Near the bottom of the euphotic zone, chlorophyll and productivity values are about an order of magnitude greater, probably due to the often intruded, nutrient-rich Loop undercurrent waters (MMS, 1990).

Productivity measurements in the oceanic waters of the Gulf of Mexico include:

- 0.1 g C/m^2/d yielding 17 g C/m^2/yr or 86 million tons of phytoplankton biomass (MMS, 1983)
- 103-250 g C/m^2/yr (Flint and Kamykowski, 1984)
- 103 g C/m^2/yr (Flint and Rabalais, 1981).

Biomass (chlorophyll a) measurements in the predominantly oceanic waters of the Gulf of Mexico include:

- 0.05-0.30 mg Chl a/m^3 (MMS, 1983a)
- 0.05-0.1 mg Chl a/m^3 (Yentsch, 1982)
- 0.22 mg Chl a/m^3 (El-Sayed, 1972)
- 0.17 mg Chl a/m^3 (Trees and El-Sayed, 1986).

For comparisons, the following data on primary productivity are presented for coastal wetland systems as compiled by Thayer and Ustach (1981):

- Salt Marshes 200-2000 g C/m^2/yr
- Mangroves 400 g C/m^2/yr
- Seagrasses 100-900 g C/m^2/yr
- *Spartina alterniflora* 1300 g C/m^2/yr
- *Thalassia* 580-900 g C/m^2/yr
- Phytoplankton 350 g C/m^2/yr

For the eastern Gulf of Mexico, biomass (chlorophyll a) measurements include the following (Yoder and Mahood, 1983):

- Surface mixed layer values of 0.1 mg/m^3
- Subsurface measurements at 40-60 m ranged from 0.2 to 1.2 mg/m^3
- Average integrated values for the water column over the 100-200 m isobath was 10 mg/m^2
- Average integrated values for the water column greater than 200 m isobath was 9 mg/m^2.

6.2. Phytoplankton

6.2.1 *Distribution*

Phytoplankton distribution and abundance in the Gulf of Mexico is difficult to measure. Shipboard or station measurements cannot provide information about large areas at one moment in time, and satellite imagery cannot provide definitive information about local conditions that may be important. Due to fluctuations in light and nutrient availability and the immobility of phytoplankton, distribution is temporally and spatially variable. Seasonal fluctuations in location and abundance are often masked by patchy distributions which human sampling designs must attempt to interpret. In addition, methods for measurement of chlorophyll or uptake of carbon cannot always resolve all questions concerning variability among or within species under different conditions, or concerning the effects of grazing on abundance.

As mentioned in the previous section, phytoplankton occupy a niche at the base of food chain as primary producers of our oceans. Herbivorous zooplankton populations require phytoplankton for maintenance and growth -- generally 30-50% of their weight each day and surpassing 300% of their weight in exceptional cases (Kennish, 1989). In the Gulf of Mexico, phytoplankton are also often closely associated with bottom organisms, and may also contribute to benthic food sources for demersal feeding fish.

Phytoplankton seasonality has been explained in terms of salinity, depth of light penetration, and nutrient availability. Generally, diversity decreases with decreased salinity and biomass decreases with distance from shore (MMS, 1990).

6.2.2 *Principal Taxa*

The principal taxa of planktonic producers in the ocean are diatoms, dinoflagellates, coccolithophores, silicoflagellates and blue-green algae (Kennish, 1989).

Diatoms. Many specialists regard diatoms as the most important phytoplankton group, contributing substantially to oceanic productivity. Diatoms consist of single cells or cell chains, and secrete an external rigid silicate skeleton called a frustule.

In 1969, Saunders and Glenn reported the following for diatom samples collected 5.6 to 77.8 km from shore in the Gulf of Mexico between St. Petersburg and Ft. Myers, Florida. Diatoms averaged 1.4 x $10^7 \mu^2$/l surface area offshore, 13.6 x $10^7 \mu^2$/l at intermediate locations and 13.0 x $10^8 \mu^2$/l inshore. The ten most important species in terms of their cellular surface area were: *Rhizosolenia alata, R. setigera, R. stolterfothii, Skeletonema costatum, Leptocylindrus danicus, Rhizosolenia fragilissima, Hemidiscus hardmanianus, Guinardia flaccida, Bellerochea malleus,* and *Cerataulina pelagica.*

Dinoflagellates. Dinoflagellates are typically unicellular, biflagellated autotrophic forms that also supply a major portion of the primary production in many regions. Some species generate toxins and when blooms reach high densities, mass mortality of fish, shellfish, and other organisms can occur (Kennish, 1989). Notably, *Gymnodinium breve* is responsible for most of Florida's red tides and several of the *Gonyaulax* species are known to cause massive blooms (Steidinger and Williams, 1970). Table 6-1 lists species and varieties of dinoflagellates found to be abundant during the Hourglass Cruises (a systematic sampling program in the eastern Gulf of Mexico.)

Coccolithophores. Coccolithophores are unicellular, biflagellated algae named for their characteristic calcareous plate, the coccolith, which is embedded in a gelatinous sheath that surrounds the cell. Phytoplankton of offshore Gulf of Mexico are reported to be dominated by coccolithophores (Iverson and Hopkins, 1981).

Silicoflagellates. Silicoflagellates are unicellular flagellated (single or biflagellated) organisms that secrete an internal skeleton composed of siliceous spicules (Kennish, 1989). Perhaps because of their small size (usually less than 30 µm in diameter) little specific information relative to Gulf of Mexico distribution and abundance, is available for this group.

Blue Green Algae. Blue green algae are prokaryotic organisms that have chitinous walls and often contain a pigment called phycocyanin that gives the algae their blue green appearance (Kennish, 1989). On the west Florida shelf, inshore blooms of the blue green algae *Oscillatoria erethraea* sometimes occur in spring or fall.

6.3 Zooplankton

Like phytoplankton, zooplankton are seasonal and patchy in their distribution and abundance. Zooplankton standing stocks have been associated with the depth of maximum primary productivity and the thermocline (Ortner et al., 1984). Zooplankton feed on phytoplankton and other zooplankton, and are important intermediaries in the food chain as prey for each other and larger fish.

As in many marine ecosystems, zooplankton fecal pellets contribute significantly to the detrital pool. The ease of mixing in Gulf coastal waters may make them extremely important to nutrient circulation and primary productivity, as well as benthic food stocks. Also contributing to the detrital pool is the concentration of zooplankton in bottom waters, coupled with phytoplankton in the nepheloid layer during times of greater water stratification.

Copepods are the dominant zooplankton group found in all Gulf waters. They can account for as much as 70% by number of all forms of zooplankton found (NOAA, 1975). In shallow waters, peaks occur in the summer and fall (NOAA, 1975), or in spring and summer, (MMS, 1983a). When salinities are low, estuarine species such as *Acartia tonsa* become abundant.

The following information on zooplankton distribution and abundance in the eastern Gulf of Mexico is summarized from Iverson and Hopkins (1981).

- During Bureau of Land Management-sponsored studies, small copepods predominated in net catches over the shelf regions of the eastern and western Gulf of Mexico.

- During Department of Energy-sponsored studies at sights located over the continental slope of Mobile and Tampa Bays, small calanoids such as *Parcalanus*, and *Clausocalanus* and cyclopoids such as *Farralanula, Oncaea*, and *Oithona* predominated at the 0-200 m depths; and larger copepods such as *Eucalanus, Rhincalnus,* and *Pleuromamma* dominated at 1,000 m depths. Euphausiids were also more conspicuous. Night-time samples taken near Tampa showed larger crustaceans such as Lucifer and Euphasia. Biomass data for the same site revealed a decrease in zooplankton with increasing depth. The mean cumulated biomass value for the upper 1,000 m was 21.9 $m\ell/m^2$.

Table 6-1. Significant Dinoflagellate Species of the Eastern Gulf of Mexico

Species	Biomass Value (μ^3)
Amphisolenia bidentata	67,039 - 95,406
Ceratium carriense	637,219 - 1,115,367
C. carriense var. *volans*	622,206 - 1,196,643
C. contortum var. *karstenii*	943,121 - 1,655,573
C. extensum	189,709 - 323,546
C. furca	23,157 - 43,369
C. fusus	34,463 - 154,722
C. hexacanthum	687,593 - 1,384,016
Ceratium hircus	211,709
C. inflatum	145,897 - 221,276
C. massiliense	543,762 - 1,002,222
C. trichoceros	104,110 - 357,437
C. tripos var. *atlanticum*	518,659 - 964,436
Dinophysis caudata var. *pedunculata*	92,153 - 231,405
Gonyaulax splendens	51,651
Prorocentrum crassipes	329,540
P. gracile	25,773
P. micans	65,412

Source: Steidinger and Williams, 1970.

- Studies funded by the National Science Foundation in the east-central Gulf found diurnal patterns of distribution in the upper 1,000 m--with increases in the 50-m range at night and in the 300-600-m zone during the day--most likely attributable to vertical migration. In the upper 200 m, in addition to copepods, group such as chaetognaths, tunicates, hydromedusae, and euphausiids were significant contributors to the biomass.

Icthyoplankton studies for the eastern Gulf conducted during 1971-1974 found fish eggs to be more abundant in the northern half and fish larvae to be more abundant in the southern half of the eastern Gulf. Mean abundances were 5,454 eggs/m^2 and 3,805 larvae/m^2 in the northern Gulf and 4,634 eggs/m^2 and 4,869 larvae/m^2 in the southern Gulf. Eggs were more abundant in waters less than 450 meters deep, where as larvae were more abundant in depth zones greater than 50 meters (Houde and Chitty, 1976).

6.4 Habitats

6.4.1 *Seagrasses*

Seagrasses are vascular plants that serve a variety of ecologically important functions. As primary producers, seagrasses are a direct food source and also contribute nutrients to the water column. Seagrass communities serve as a nursery habitat for juvenile fish and invertebrates and seagrass blades provide substrate for epiphytes. Species such as *Thalassia testudinum* have an extensive root system that stabilize substrate, and broad ribbon-like blades that increase sedimentation. Seagrasses mainly occur in shallow, clear, highly saline waters. Seagrass beds do not occur in the proposed activity area (MMS, 2000).

Of the more than 3 million hectares (1 ha = 2.471 acres) of submerged seagrass beds in the shallow coastal waters of the northern Gulf of Mexico, 98.5% is found off the Florida coast and 1% is found off the Mississippi and Alabama coasts. The most predominant species is *Thalassia testudinum*, commonly known as turtle grass -- average biomass values for turtle grass are 500-3,100 g/m^2. Other common seagrass species include: *Syringodium filiforme* (manatee grass), average biomass production of 100-300 g/m^2; *Halodule wrightii* (shoal grass) average biomass value of 50-250 g/m^2; and three Halophila species that tend to be less productive than aforementioned species (MMS, 1990).

6.4.2 *Offshore Habitats*

Offshore habitats include the water column and the sea floor. The eastern Gulf benthos consist primarily of low relief live-bottom areas. Live-bottom areas contain biological assemblages consisting of such sessile invertebrates as sea fans, sea whips, hydroids, anemones, ascideians sponges, bryozoans, seagrasses, or corals living upon and attached to naturally occurring hard or rocky formation with fishes and other fauna. Live-bottom types include pinnacle-trend, low-relief, offshore seagrasses, and coral reef communities. Coral reef communities are not found within the proposed permit coverage area and are therefore not discussed in this document. Within the eastern Gulf, live-bottom communities are scattered across the west Florida shelf and at the outer edge of the Mississippi/Alabama shelf.

6.4.2.1 Deepwater Benthic Resources

The proposed BP Amoco project will occur in water depths in excess of 1000 m. Deepwater benthic habitats, as discussed here, refer to those in water depths greater than 305 m (1000 ft). A number of unique habitat and community types occur in the deepwaters of the Gulf of Mexico.

Chemosysthetic Communities

The following descriptions of chemosynthetic communities in the deepwater Gulf of Mexico are taken from pages IV-3 to IV-7 in: *Gulf of Mexico Deepwater Operations and Activities, Environmental Assessment (MMS, 2000)*:

Description

Chemosynthetic communities are remarkable in that they utilize a carbon source independent of photosynthesis and the sun-dependent photosynthetic food chain that supports all other life on earth. Although the process of chemosynthesis is entirely microbial, chemosynthetic bacteria and their production can support thriving assemblages of higher organisms through symbiosis. The first discovery of deep-sea chemosynthetic communities including higher animals was unexpectedly made at hydrothermal vents in the eastern Pacific

Ocean during geological explorations (Corliss et al., 1979). The principal organisms included tube worms, clams, and mussels that derive their entire food supply from symbiotic chemosynthetic bacteria, which obtain their energy needs from chemical compounds in the venting fluids. Similar communities were first discovered in the Eastern Gulf of Mexico in 1983 at the bottom of the Florida Escarpment in areas of "cold" brine seepage (Paull et al., 1984). The fauna here was found to be generally similar to vent communities including tube worms, mussels, and rarely, vesicomyid clams.

Chemosynthetic communities in the Central Gulf of Mexico were fortuitously discovered by two groups concurrently in November 1984. During investigations by Texas A&M University to determine the effects of oil seepage on benthic ecology (until this investigation, all effects of oil seepage were assumed to be detrimental), bottom trawls unexpectedly recovered extensive collections of chemosynthetic organisms including tube worms and clams (Kennicutt et al., 1985). At the same time, LGL Ecological Research Associates was conducting a research cruise as part of the multiyear MMS Northern Gulf of Mexico Continental Slope Study (LGL and Texas A&M University, 1986). Bottom photography resulted in clear images of vesicomyid clam chemosynthetic communities. A subsequent LGL/MMS cruise also photographically documented tube worm communities in situ in the Central Gulf of Mexico (Boland, 1986) prior to the initial submersible investigations and firsthand descriptions of Bush Hill in 1986 (Rosman et al., 1987; MacDonald et al., 1989).

Distribution

The northern Gulf of Mexico slope includes a stratigraphic section more than 10 km thick and has been profoundly influenced by salt movement. Oil in most of the Gulf slope fields is generated by Mesozoic source rocks from Upper Jurassic to Upper Cretaceous in age (Sassen et al., 1993). Migration conduits supply fresh hydrocarbon materials through a vertical scale of 6-8 km toward the surface. The surface expressions of hydrocarbon migration are referred to as seeps. Geological evidence demonstrates that hydrocarbon and brine seepage persists in spatially discrete areas for thousands of years. The time scale for oil and gas migration (combination of buoyancy and pressure) from source systems is on the scale of millions of years (Sassen, 1997).

There is a clear relationship between known hydrocarbon discoveries at great depth in the Gulf slope and chemosynthetic communities, hydrocarbon seepage, and authigenic minerals including carbonates at the seafloor (Sassen et al., 1993). While the hydrocarbon reservoirs are broad areas several kilometers beneath the Gulf, chemosynthetic communities are isolated areas involving thin veneers of sediment only a few meters thick. Seepage from hydrocarbon seeps tends to be diffused through the overlying sediment, so the corresponding hydrocarbon seep communities tend to be larger (a few hundred meters wide) than chemosynthetic communities found around the hydrothermal vents of the Eastern Pacific (MacDonald, 1992). There are large differences in the concentrations of hydrocarbons at seep sites.

The widespread nature of Gulf of Mexico chemosynthetic communities was first documented during contracted investigations by the Geological and Environmental Research Group (GERG) of Texas A&M University for the Offshore Operators Committee (Brooks et al., 1986). The occurrence of chemosynthetic organisms dependent on hydrocarbon seepage has been documented in water depths as shallow as 290 m (Roberts et al., 1990) and as deep as 2,200 m (MacDonald, 1992). This depth range specifically places *chemosynthetic communities in the deepwater region of the Gulf of Mexico, which is defined as water depths greater than 305 m (1,000 ft). Chemosynthetic communities are not found on the continental shelf. At least 43 communities are now known to exist in 41 OCS blocks. Although a systematic survey has not been done to identify all chemosynthetic communities in the Gulf, there is evidence indicating that many more such communities exist. The depth limits of discoveries probably reflect the limits of exploration (lack of submersibles capable of depths over 1,000 m). MacDonald et al. (1993 and 1996) have analyzed remote-sensing images from space that reveal the presence of oil slicks across the north-central Gulf of Mexico. Results confirmed extensive natural oil seepage in the Gulf, especially in water depths greater than 1,000 m. A total of 58 additional potential locations were documented where seafloor sources were capable of producing perennial oil slicks (MacDonald et al., 1996). Estimated seepage rates ranged from 4 to 70 bbl/day compared to less than 0.1 bbl/day for ship discharges (both normalized for 1,000 mi2 (3,430 km2)). This evidence considerably increases the area where chemosynthetic communities dependent on hydrocarbon seepage may be expected. The densest aggregations of chemosynthetic organisms have been found at water depths of around 500 m and deeper. The best known of these communities was named Bush Hill by the investigators who first described it (MacDonald et al., 1989). It is a surprisingly large and dense community of chemosynthetic tube worms and mussels at a site of natural petroleum and gas seepage over a salt diapir in Green Canyon Block 185. The seep site is a small knoll that rises about 40 m above the surrounding seafloor in about 580-m water depth.*

Stability

According to Sassen (1997) the role of hydrates at chemosynthetic communities has been greatly underestimated. The biological alteration of frozen gas hydrates was first discovered during the recent MMS study "Stability and Change in Gulf of Mexico Chemosynthetic Communities." It is hypothesized (MacDonald, 1998) that the dynamics of hydrate alteration could play a major role as a mechanism for regulation of the release of hydrocarbon gases to fuel biogeochemical processes and could also play a substantial role in community stability Recorded, bottom-water temperature excursions of several degrees in some areas such as the Bush Hill site (4-5 °C at 500-m depth) are believed to result in dissociation of hydrates, resulting in an increase in gas fluxes (MacDonald et al., 1994). Although not as destructive as the volcanism at vent sites of the mid-ocean ridges, the dynamics of shallow hydrate formation and movement will clearly affect sessile animals that form part of the seepage barrier. There is potential of a catastrophic event where an entire layer of shallow hydrate could break free of the bottom and result in considerable impact to local communities of chemosynthetic fauna. At deeper depths (>1,000 m), the bottom-water temperature is colder (by approximately 3°C) and undergoes less fluctuation. The formation of more stable and probably deeper hydrates influences the flux of light hydrocarbon gases to the surface, thus influencing the surface morphology and characteristics of chemosynthetic communities. Within complex communities such as Bush Hill, oil seems less important than previously thought (MacDonald, 1998).

Through taphonomic studies (death assemblages of shells) and interpretation of seep assemblage composition from cores, Powell (1995) reported that, overall, seep communities were persistent over periods of 500-1,000 years. Some sites retained optimal habitat over geological time scales. Powell reported evidence of mussel and clam communities persisting in the same sites for 500-4,000 years. Powell also found that both the composition of species and trophic tiering of hydrocarbon seep *communities tend to be fairly constant across time, with temporal variations only in numerical abundance. He found few cases in which the community type changed (from mussel to clam communities, for example) or had disappeared completely. Faunal succession was not observed. Surprisingly, when recovery occurred after a past destructive event, the same chemosynthetic species reoccupied a site. There was little evidence of catastrophic burial events, but two instances were found in mussel communities in Green Canyon Block 234. The most notable observation reported by Powell (1995) was the nearly perpetual uniqueness of each chemosynthetic community site.*

Precipitation of authigenic carbonates and other geologic events will undoubtedly alter surface seepage patterns over periods of 1-2 years, although through direct observation, no changes in chemosynthetic fauna distribution or composition were observed at seven separate study sites (MacDonald et al., 1995). A slightly longer period (12 years) can be referenced in the case of Bush Hill, the first community described in situ in 1986. No mass die-offs or large-scale shifts in faunal composition have been observed (with the exception of collections for scientific purposes) over the 12-year history of research at this site.

Biology

MacDonald et al. (1990) has described four general community types. These are communities dominated by Vestimentiferan tube worms (Lamellibrachia c.f: barhami and Escarpia n.sp.), mytilid mussels (Seep Mytilid Ia, Ib, and III, and others), vesicomyid clams (Vesicomya cordata and Calyptogena ponderosa), and infaunal lucinid or thyasirid clams (Lucinoma sp. or Thyasira sp.). These faunal groups tend to display distinctive characteristics in terms of how they aggregate, the size of aggregations, the geological and chemical properties of the habitats in which they occur and, to some degree, the heterotrophic fauna that occur with them. Many of the species found at these cold seep communities in the Gulf are new to science and remain undescribed. As an example, at least six different species of seep mussels have been collected but none is yet described.

Individual lamellibranchid tube worms, the longer of two taxa found at seeps (the other is Escarpia sp.) can reach lengths of 3 m and live hundreds of years (Fisher et al., 1997). Growth rates determined from recovered marked tube worms have been variable, ranging from no growth of 13 individuals measured one year to a maximum growth of 20 mm per year in a Lamellibrachia individual. Average growth rate was 2.5 mm/yr for escarpids and 7.1 mm/yr for lamellibrachids. These are slower growth rates than those of their hydrothermal vent relatives, but Lamellibrachia individuals can reach lengths 2-3 times that of the largest known hydrothermal vent species. Individuals of Lamellibrachia sp. in excess of 3 m have been collected on several occasions representing probable ages in excess of 400 years (Fisher, 1995). Vestimentiferan tube worm spawning is not seasonal and recruitment is episodic.

Growth rates for methanotrophic mussels at cold seep sites have recently been reported (Fisher, 1995). General growth rates were found to be relatively high. Adult mussel growth rates were similar to mussels from a littoral environment at similar temperatures. Fisher also found that juvenile mussels at hydrocarbon seeps initially grow rapidly, but the growth rate drops markedly in adults; they grow to reproductive size very quickly. Both individuals and communities appear to be very long lived. These methane-dependent mussels (Type Ia) have strict chemical requirements that tie them to areas of the *most active seepage in the Gulf of Mexico. As a result of their rapid growth rates, mussel recolonization of a disturbed seep site could occur relatively rapidly. There is some early evidence that mussels also have some requirement of a hard substrate and could increase in numbers if suitable substrate is increased on the seafloor (Fisher, 1995).*

Unlike mussel beds, chemosynthetic clam beds may persist as a visual surface phenomenon for an extended period without input of new living individuals because of low dissolution rates and low sedimentation rates. Most clam beds investigated by Powell (1995) were inactive. Living individuals were rarely encountered. Powell reported that over a 50-year timespan, local extinctions and recolonization should be gradual and exceedingly rare.

Extensive mats of free-living bacteria are also evident at hydrocarbon seep sites. These bacteria may compete with the major fauna for sulfide and methane energy sources and may also contribute substantially to overall production (MacDonald, 1998). The white "nonpigmented" mats were found to be an autotrophic sulfur bacteria Beggiatoa species, and the orange mats possessed an unidentified nonautotrophic metabolism (MacDonald, 1998).

Preliminary information has been presented by Carney (1993) concerning the nonchemosynthetic animals (heterotrophs) found in the vicinity of hydrocarbon seeps. Heterotrophic species at seep sites are a mixture of species unique to seeps and those that are a normal component from the surrounding environment. Carney reports a potential imbalance that could occur as a result of chronic disruption. Because of sporadic recruitment patterns, predators could gain an advantage, resulting in exterminations in local populations of mussel beds.

The following descriptions of nonchemosynthetic communities in the deepwater Gulf of Mexico are taken from pages IV-14 to IV-16 in: *Gulf of Mexico Deepwater Operations and Activities, Environmental Assessment (MMS, 2000)*:

Nonchemosynthetic Benthic Communities

Description

More than chemosynthetic communities are found on the bottom of the deep Gulf of Mexico. Other types of communities include the full spectrum of living organisms also found on the continental shelf or other areas of the marine environment. Major groups include bacteria and other microbenthos, meiofauna (0.063-0.3 mm), macrofauna (greater than 0.3 mm), and megafauna (larger organisms such as crabs, sea pens, crinoids, demersal fish, etc.). All of these groups are represented throughout the entire Gulf--from the continental shelf to the deepest abyss of the Gulf at about 3,850 m (12,630 fit). Enhanced densities of these heterotrophic communities (nonchemosynthetic) occurring in association with chemosynthetic communities have been described (Carney, 1993). Some of these heterotrophic communities found at and near seep sites are a mixture of species unique to seeps and those that are a normal component from the surrounding environment. Because of their very close proximity to chemosynthetic communities, their relevance (and possible impact mitigation) is best considered as part of the previous chemosynthetic community analysis and associated mitigation measures (e.g., NTL 98

There are also rare examples of deepwater communities that would not be considered typical of the deep Gulf of Mexico continental slope. One example is represented by what was reported as a deepwater coral reef by Moore and Bullis (1960). In an area measuring 300 m in length and more than 20 nmi from the nearest known chemosynthetic community (Viosca Knoll Block 907), a trawl collection from a depth of 421 -512 m retrieved more than 300 pounds of the scleractinian coral Lophelia prolifera. This type of unusual and unexpected community may exist in many other areas of the deep Gulf of Mexico. Because of the difficulty and expense of exploring the deep sea, only a very small percentage of the bottom has been studied below a depth of 300 m.

Past Research

The first substantial collections of deep Gulf benthos were made during the cruises of the U.S. Coast and Geodetic Steamer Blake between 1877 and 1880. Rowe and Menzel (1971) reported that their deep Gulf of Mexico infauna data were the first quantitative data published for this region. Pequegnat (1983) summarized this early work including research through the early 1970's and his own data from research at 264 stations across the deep Gulf in the 1960's at depths ranging from 150 to 3,850 m. The Pequegnat final report for MMS, primarily qualitative in nature, first described numerous hypotheses of depth zonation patterns and aspects of faunal differences between the eastern and western Gulf of Mexico.

The first major quantitative deepwater benthos study in the Gulf of Mexico was that of LGL Ecological Research Associates Inc. (Gallaway et al., 1988) as part of the MMS Northern Gulf of Mexico Continental Slope Study. This multiyear project is certainly the most comprehensive of all previous research in the Gulf of Mexico deep sea. Gallaway et al. (1988) reported that after their benthic study results, it was possible to predict with a reasonable degree of certainty the basic composition of the faunal communities on the northern Gulf of Mexico slope between 300 and 2,500 m between 85 ° and 94° W. longitude, approximately 75 percent of the northern Gulf slope area. There was a reasonable degree of agreement between the faunal distribution results of the LGL study (Gallaway et al., 1988) and Pequegnat (1983). Because of the fact that the deep Gulf has only recently been investigated in any systematic way, a large number of species obtained during the LGL/MMS study were new to science.

Bacteria

Limited research has been done on bacteria in the deep sea and especially in the deep Gulf of Mexico. Controls of bacterial abundance in marine sediments remain poorly understood (Schmidt et al., 1998). Recent results also reported by Schmidt et al. (1998) suggest that bacterial abundance is relatively constant over a wide variety of geographic regions when direct bacterial counts are scaled to fluid volume (pore water) compared to the traditional dimension of dryg sediment mass. In any event, the counts of bacteria in marine sediments center around 10 bacteria per ml fluid volume, in other words, literally trillions per m2.

Meiofauna

The density of meiofauna was reported as approximately two orders of magnitude greater than the density of macrofauna throughout the depth range of the Gulf of Mexico continental slope by LGL/MMS (Gallaway et *al., 1988). Overall mean abundance was 707 individuals per 10 cm2 (707,000 per m2). Densities were generally similar to those previously reported and generally decreased with increasing depth. A total of 43 major groups were identified. Of these, representatives of five taxa of permanent meiofauna (Nematode, Harpacticoidea, Polychaeta, Ostracoda, and Kinorhyncha), along with naupliar larvae (temporary meiofauna), comprised 98 percent of the collections as reported by Gallaway et al. (1988). The range of density values obtained for meiofauna varied by one order of magnitude. Some comparisons with depth showed a decisive decrease of abundance with depth (at the 5% statistical level), but this trend was not consistent through all seasons and areas of the Gulf.*

Macrofauna

Gallaway et al. (1988) reported a total of 1,569 different taxa of macrofauna on the continental slope, 90 percent of those identified to the level of genus or species. Nearly all macrofaunal species were infaunal invertebrates, although some taxa were normally found in surficial sediments, considered nominally epifaunal or surface dwelling. The major group was annelid taxa including 626 ~olychette taxa. Overall abundance of macrofauna ranged from 518 to 5,369 individuals per m. Overall, there was a general pattern of decreased macrofaunal density with depth.

Megafauna

Megafauna collections were made utilizing two techniques in Gallaway et al. (1988), benthic photography and the use of an otter trawl ranging in depth between 300 and 2,882 m. Based on fish and invertebrates collected by trawling, invertebrates were four to five times more abundant than benthic fishes throughout all transects and designated depth zones. Other trends included higher densities of all megafauna in the study's eastern Gulf transect area (between 85°40' and 85°15' W.) and lowest in the central area (between 89°40' and 89°20' W.), and a tendency of densities to decrease below a depth of 1,550 m. Overall, benthic fish densities ranged from 0 to 704 fish per hectare (10,000 m2). Overall megafauna invertebrates ranged from 0 to 4,368 individuals per hectare. Results of the LGL studies (Gallaway et al., 1988) supported the zonation scheme proposed by Pequegnat (1983).

All 60 stations in the MMS continental slope study (Gallaway et al., 1988) were also sampled by quantitative photographic methods. Although up to 800 images were obtained at each of the stations, due to the relatively small area "sampled" by each photograph (approximately 2 m2), abundance of most megafauna taxa was low. Megafauna that did appear in benthic photographs generally indicated much higher densities than that obtained by trawling, with variations being more than four orders of magnitude in some cases. Overall density from photography was 8,449 animals per ha. The highest density of any organism sampled by photography was that of a small sea cucumber (never obtained by trawling) resulting in a peak density of 154,669 individuals per ha.

While the previous groups of sediment-dwelling organisms could be considered immobile and unable to avoid disturbances caused by OCS activities, megafauna could be categorized into two groups: a nonmotile or very slow-moving group including many invertebrates, and a motile group including fish, crustaceans, and some other types of invertebrates such as semi-pelagic sea cucumbers.

6.5 Fishes

The following section describes some of the species of fish and shrimp that occupy the waters of Alabama, Florida, and Mississippi. These species were chosen because of their commercial, recreational, and/or ecological significance and their occurrence in offshore waters of the eastern Gulf. The commercial and recreational fisheries associated with these species are described in Chapter 7 of this document.

6.5.1 *Spotted Seatrout*

Spotted seatrout (*Cynoscion nebulosus*) are restricted mainly to estuaries and emigrate only during periods of environmental extremes or in association with spawning, feeding, and protection from predators (Lorio and Perret, 1980). The importance of estuaries to this species was emphasized by Etzold and Christmas (1979) who pointed out that spotted seatrout not only spawn in estuaries but also depend on estuaries for food throughout their life span. Spotted seatrout spawn from spring through early fall in deep channels and depressions in estuaries (Lorio and Perret, 1980). Larvae move into grassbeds and marshes where growth occurs rapidly. As they develop, they move into deeper portions of the estuary. During spring and summer, adults concentrate in inlets and passes to feed on migrating shrimp and small fish.

6.5.2 *Sand Seatrout*

A demersal species, the sand seatrout (*Cynoscion arenarius*) is one of the most abundant fish in the estuaries and continental shelf waters of the Gulf of Mexico (Moffett et al., 1979; Shlossman, 1980; NOAA, 1985). Juveniles and prespawners are found in estuarine and coastal waters, and adults are generally found to the edge of the continental shelf. Spawning occurs from March to September in grounds located in Gulf waters between 15 and 50 meters deep. From spring through fall, juveniles occupy nursery areas located further inshore and in estuaries. Salt marshes also may be used during the early stages of growth. In the late fall, juveniles leave estuarine nursery areas to winter in the open Gulf waters. Adults migrate to spawning grounds in the spring.

6.5.3 *Red Drum*

The red drum (*Sciaenops ocellatus*) inhabits estuaries and coastal waters out to distances of 25 km at depths up to 50 m (NOAA, 1985; 1986). Certain adult populations may live exclusively in open waters while others live in bay systems (Simmons and Breuer, 1962). After first spawning, adults tend to spend more time in Gulf waters and less time in estuaries (NOAA, 1986). Spawning occurs in the fall and winter throughout coastal waters outside of estuaries and in and near barrier island passes to estuaries (Christmas and Waller, 1973; Johnson, 1978; NOAA, 1985). The young fish are carried into the shallow estuaries and tend to associate with seagrasses and marshes (Yokel, 1966; Jannke, 1971; Loman, 1978). Although found in coastal areas throughout the year, the red drum resides in estuaries in the summer and offshore in the winter.

6.5.4 *Tarpon*

Tarpon (*Megalops altanticus*) are pelagic fish found throughout the nearshore zone of the Gulf of Mexico in waters mostly to depths of 20 m and rarely to 100 m (Wade and Robins, 1972; McClane, 1974; Smith, 1980; U.S. FWS, 1978; NOAA, 1985). Tarpon usually inhabit nearshore areas, estuaries, inlets, passes, and occasionally freshwater rivers. Spawning occurs from May to August in offshore waters. The larvae move inshore, and juveniles are found in nearshore, estuarine, and freshwater areas. As size increases, movement toward ocean waters occurs. Tarpon may also move in and out of estuaries, depending on temperature.

6.5.5 *Red Snapper*

Red snapper (*Lutjanus campechanus*), a demersal fish, is usually found seaward of the 18-m bottom contour (occasionally up to 1,200 m) over a variety of surfaces, congregating in depressions or near coral and rock outcrops (U.S. FWS, 1978; Collins et al., 1980; GMFMC, 1980; Benson, 1982; NOAA, 1985). Individuals generally move inshore in the summer and offshore in the winter. Spawning occurs offshore in water depths from 15 to 40 m over hard sand and reefs from June to October. Larvae remain in offshore waters near the bottom; juveniles inhabit estuaries and shallow inshore areas, beaches, and channels. As juveniles mature, they move into deeper waters.

6.5.6 *Spanish and King Mackerel*

The Spanish and king mackerel (*Scomberomorus maculatus* and *S. cavalla*) are migratory pelagic species found in estuaries and coastal waters to depths of 100 to 200 m (NOAA, 1985). Large schools are known to pass near the beach during seasonal migrations (GMSAFMC, 1985) and may enter tidal estuaries, bays, and lagoons (Berrien and Finan, 1977). Mackerel spawn from spring to fall in shallow waters, usually less than 20 m deep (McEachran et al., 1980; NOAA, 1985; Godcharles and Murphy, 1986). Mackerel seldom enter brackish waters (NOAA, 1985). Some juveniles use estuaries as nursery grounds, but most stay nearshore in open beach waters (Kelly, 1965).

6.5.7 *Atlantic Croaker*

Atlantic croaker (*Micropogonias undulatus*) are demersal bony fish found in estuarine and coastal waters seaward to approximately 120 m depths. The species is estuarine-dependent; all life stages are abundant in estuarine waters (Lassuy, 1983a). When inshore temperatures are high in late spring to early fall, heavy concentrations of croakers are found inside the 20-m depth, and when inshore temperatures drop, populations move offshore (GMFMC, 1980). Croakers appear to spawn during fall and winter from open waters near passes and channel entrances to estuaries in water depths up to 20 m (Juhl et al., 1975; White and Chittenden, 1977; Warren et al., 1978; NOAA, 1985). Larvae are first pelagic and soon become demersal, moving into estuarine nursery grounds where transition to the juvenile stage occurs (Fruge and Truesdale, 1978; Diaz and Onuf, 1985). Young croakers remain in estuaries at least through spring or early summer before migrating to open waters (Lassuy, 1983a).

6.5.8 *Groupers*

Groupers are demersal reef fish that are found at depths of 30-120 m, favoring vertical relief areas such as natural and artificial reefs or rock outcroppings. Juveniles are found in grass beds, rock formations, and shallow reef areas. Spawning occurs over the continental shelf from January to July depending on the species. Common species in the Gulf of Mexico include the red grouper (*Epinephelus morio*) and the black grouper (*Myoteroperca bonaci*).

6.5.9 *Southern Flounder*

The southern flounder (*Paralichthys lethostigma*) occurs in the western Atlantic from North Carolina to the Loxahatchee River, Florida and in the Gulf of Mexico from the Calooshatchee River, Florida to Laguna de Tamiahua, Mexico. Adults are found to 60 meters depths during winter spawning. Nursery areas are in estuaries. Prey include other demersal fish, crabs, and shrimp.

6.5.10 *Pinfish*

Pinfish inhabit rocky or vegetated marine bottoms, reefs, jetties, and mangrove swamps and are believed to have a significant impact on epifaunal seagrass communities. They prey on crustaceans such as amphipods and shrimp. Their predators include ladyfish, porpose, spotted seatrout, alligator gar, and gulf flounder (Muncy, 1984b).

6.5.11 *Saltwater Catfish*

Saltwater catfish in the Gulf of Mexico include sea catfish and gafftopsail catfish. They are opportunistic feeders that prefer sandy and organic substrate. Their diet includes sea grass, corals, sea cucumbers, gastropods, polychaetes, and crustaceans (Muncy and Wingo, 1983).

6.6 Deepwater Fishes of the Gulf of Mexico

The following discussion of the deepwater fishes of the Gulf of Mexico is taken from pp. 260-265 in: *Deepwater Gulf of Mexico Environmental and Socioeconomic Data Search and Literature Synthesis, Volume 1: Narrative Report* (CSA, 2000).

Mesopelagic Fishes

Mesopelagic fishes are generally found from 200 to 1,000 m depths in the water column. This group is phylogenetically primitive and among the most morphologically specialized of fishes (Marshall 1979). Their long evolutionary history has presumably allowed for the adaptive radiation that has occurred in response to the cold, dark midwater environment (Marshall 1979). Mesopelagic fish assemblages in the Gulf of Mexico are taxonomically diverse, consisting of eight orders comprising 30 families with 213 species (Table 10.2). The most specious groups are stomatiids *(dragonfishes), myctophids (lanternfishes), and gonostomatids (bristlemouths). These and all other taxonomic groups listed in Table 10.2 are entirely restricted to the midwater environment. The Stomiidae with 73 species are the most diverse family of fishes known for the Gulf of Mexico (Sutton and Hopkins 1996a; McEachran and Fechhelm 1998). The second most diverse group is the myctophids represented by 49 species in the Gulf of Mexico (Backus et al. 1977; Gartner et al. 1987).*

T.L. Hopkins, his students, and colleagues have contributed most of the information on mesopelagic fish ecology in the Gulf of Mexico. This group has published data on species composition, abundance, biomass, vertical migration patterns, reproductive patterns, and trophic structure for the common families. Common families include gonostomatids, myctophids, sternoptychids (hatchetfish), and stomiids (e.g., Hopkins and Lancraft 1984; Hopkins and Baird 1985b; Gartner et al. 1987; Gartner 1993; Sutton and Hopkins 1996a).

Table 10.2. Orders and families of mesopelagic and bathypelagic fishes known from the Gulf of Mexico, arranged in phylogenetic order (following McEachran and Fechhelm 1998)

MESOPELAGIC (200-1,000 m)	MESOPELAGIC (200-1,000 m) (continued)
Order Anguilliformes	**Order Stephanoberyciformes**
Nemichthyidae (snipe eels)	Gibberichthyidae
Order Osmeriformes	Melamphaidae (bigscales)
Microstomatidae (microstomatids)	Stephanoberycidae
Order Stomiiformes	Barbourisiidae
	Cetomimidae (whalefishes)
Gonostomatidae (bristlemouths)	Mirapinnidae
Sternoptychidae (marine hatchetfishes)	Rondeletiidae
Phosichthyidae (lightfishes)	**Order Beryciformes**
Astronesthidae (snaggletooths)	Anoplogasteridae (fangtooth)
Chauliodontidae (viperfishes)	Diretmidae (spinyfins)
Idiacanthidae (black dragonfishes)	
Malacosteidae (loosejaws)	**BATHYPELAGIC (>1,000 m)**
Melanostomidae (scaleless dragonfishes)	**Order Osmeriformes**
Stomiidae (scaly dragonfishes)	Argentinidae (argentines)
	Bathylagidae (deep-sea smelts)
Order Aulopiformes	Opisthoproctidae (spookfishes)
Giganturidae (giganturids)	Platytroctidae (tubeshoulders)
Aulopidae (flagfins)	**Order Aulopiformes**
Scopelarchidae (pearleyes)	Notosudidae
Alepisauridae (lancetfishes)	Omosudidae
Evermannellidae (sabertooth fishes)	**Order Gadiformes**
Paralepididae (barracudinas)	Melanonidae (pelagic cods)
Order Myctophiformes	**Order Lophiiformes**
Myctophidae (lanternfishes)	Ceratiidae (seadevils)
Neoscopelidae (neoscopelids)	Diceratiidae (deep-sea anglers)
Order Lampridiformes	Himatolophidae (football fishes)
Stylephoridae (tube-eye)	Linophrynidae
Trachipteridae (ribbonfishes)	Melanocetidae
	Oneirodidae

Mesopelagic fishes tend to be small and can be extremely abundant; they are often responsible for the deep scattering layer in sonar images of the deep sea. Gonostomatids *(bristlemouths) numerically dominated mesopelagic fish collections in the Gulf of Mexico (Murdy et al. 1983; Hopkins and Lancraft 1984). The genus Cyclothone contributed 34% of the numbers (1 to 2 fish m^{-2}) of micronekton in the upper 1,000 m (Hopkins and Lancraft 1984). Another species, Gonostoma elongatum, exhibited a density of 0.2 fish m^{-2} and standing stock of 75.6 mg m^{-2} (dry weight) (Lancraft et al. 1988). The second most abundant group was the myctophids (lanternfishes). The most abundant myctophid species in the eastern Gulf were Ceratoscopelus warmingii, Notolychnus valdiviae, Lepidophanes guentheri, Lampanyctus alatus, Diaphanus dumerilii, Benthosema suborbitale, and Myctophum affine (Gartner et al. 1987). The most common sternoptychids (hatchetfishes) collected were Argyropelecus aculeatus, A. hemigymnus, Sternoptyx diaphana, and S. psuedobscura (Hopkins and Baird 1985b). These four species ranged in abundance from 0.021 to 0.053 fish m^{-2} in the upper1,000 m (Hopkins and Baird 1985b). For the entire stomiid assemblage sampled in the upper 1,000 m of the eastern Gulf, minimum biomass and standing stock estimates were 1.86 individuals m^{-2} and 35.3 kg km^{-2} (dry weight). The most abundant stomiid species were Photostomias guernei, Chauliodus sloani, and Stomias affinis.*

A common characteristic of mesopelagic fishes is the phenomenon of diel vertical migration. Many species will migrate vertically each night from depths of 400 to 800 m into epipelagic waters, often reaching the surface. This phenomenon has been studied for several of the common Gulf of Mexico species and three basic patterns have been found: synchronous migration, asynchronous migration, and no migration. Synchronous migration is when all individuals of a species undergo nocturnal vertical migration. Individuals of Gonostoma elongatum were found to migrate synchronously, moving from daytime depths of 425 to 725 m to 25 to 325 m depths at night (Lancraft et al. 1988). This species migrated as much as 400 m vertically, but never occurred above the 25 m layer. Myctophids, also synchronous migrators, spend the daytime in depths of 200 to 1,000 m, but migrate vertically at night into near-surface waters. Individual myctophid species migrated in patterns that formed a complex series of layers of migrating fishes that clearly separated into 5 day and 5 night groups (Gartner et al. 1987). Four stomiid species of the genus Astronesthes also migrated synchronously between 400 to 700 m and 0 to 200 m. There was also circumstantial evidence of bathypelagic (below 1,000 m) to epipelagic (0 to 300 m) migration by two other stomiid species, Echiostomias barbatum and Leptostomias bilobatus (Sutton and Hopkins 1996a). The most abundant stomiids (P. guernei, C. sloani, and S. affinis) were asynchronous vertical migrators; about half of the individuals migrated from 500 to 900 m depths to 20 to 300 m at night while other half of the individuals remained at daytime depths (Sutton and Hopkins 1996a). Hatchetfishes of the genus Sternoptyx were found not to migrate and remained in 500 to 800 m depths throughout the diel cycle (Hopkins and Baird 1985b). Two species of the genus Argyropelecus did migrate into the epipelagic zone at night to feed upon zooplankton.

Feeding cycles correspond closely with vertical migratory patterns in mesopelagic fishes, and hunger may be an important driving force behind diel migrations. Many midwater species depend upon the food-rich epipelagic layers to fulfill their daily energy requirements. In general, three feeding guilds are recognized for mesopelagic fishes: micronekton feeders, zooplankton feeders, and generalists (Gartner et al. 1997). Representatives from all of these groups occur in the Gulf of Mexico (Hopkins et al. 1997). Myctophids, sternoptychids, and gonostomatids were the primary zooplankton feeding taxa. They consumed 31 %, 27%, and 14% of the planktonic food biomass eaten daily by the midwater assemblage (Hopkins et al. 1997). The primary fish-consuming family was the Stomiidae, accounting for 61% of all fish eaten.

Myctophids fed mostly on crustacean zooplankton (copepods) (Hopkins and Baird 1985a; Hopkins and Gartner 1992; Hopkins et al. 1997). The hatchetfish A. aculeatus appeared to migrate vertically into the epipelagic zone where young stages consumed ostracods and copepods and larger individuals consumed pteropods and euphausiids. All size classes of A. hemigymnus foraged at 300 to 500 m on ostracods and copepods. Juvenile S. diaphana ate copepods, ostracods, and amphipods, and adults consumed mostly amphipods and euphausiids in water depths of 500 to 800 m. S. hemigymnus remained below 800 m where juveniles fed upon copepods, polychaetes, and euphausiids, and adults fed upon amphipods and fishes (Hopkins and Baird 1985b). The gonostomatid G. elongatum fed mainly upon copepods and ostracods as young individuals, and on euphausiids as adults mostly at night in the epipelagic zone (Lancraft et al. 1988).

Stomiids proved to be an important upper level group of predators in the pelagic food web (Sutton and Hopkins 1996a). The stomiid assemblage formed four basic categories with respect to food habits: myctophid predation, zooplankton/small micronekton predation, penaeidean shrimp predation, and copepod/micronekton predation (Sutton and Hopkins 1996b). The stomiids investigated were selective with respect to prey items ingested. Stomiids inflict the highest predation impact on myctophids in low-latitude ecosystems, and historic use of predation-avoidance arguments to explain certain mesopelagic phenomena (e.g., vertical migration, ventral photophores) appears to be substantiated. The stomiids may be important in the transport of energy from the mesopelagic to the bathypelagic and benthopelagic.

Hopkins and colleagues (Gartner et al. 1987; Hopkins and Gartner 1992; Hopkins et al. 1997; Hopkins and Sutton 1998) interpreted much of the observed interplay between vertical migration and feeding mode in the light of ecological competition among fish and invertebrate species. Considerable dietary overlap was found among the abundant myctophid species that inhabit the epipelagic zone at night (Hopkins and Gartner 1992). When both vertical distribution and diet were considered together, little inter- or intra-specific overlap occurred. This was construed as a prime example of resource partitioning that evolved in response to competition during the evolution of the midwater ecosystem. The high degree of overlap in diet allows species packing in an otherwise structureless water column (the epipelagic zone at night).

The daily consumption of the eastern Gulf midwater assemblage was estimated to be 2.5 to 4.3 kg C km^{-2} in the upper 1,000 m (Hopkins et al. 1997). Most (80%) of this was provided by zooplankton and the remainder was larger prey, mostly fish. The ingestion rates accounted for only 5% to 10% of the daily production, but 95% of fish daily production. These dietary findings agree with similar studies performed in other oligotrophic regions of the oceans. In Chapter 6 of this report, Biggs and Ressler argue that for areas other than the eastern Gulf, and where productivity "hot spots" occur, the pelagic environment is more productive, or mesotrophic.

Bathypelagic Fishes

The deeper dwelling bathypelagic fishes inhabit the water column at depths greater than 1,000 m and seldom migrate into shallower waters. This group is composed of bizarre, little-known species such as gulper eels, slickheads, deep-sea anglers, bigscales, and whalefishes (McEachran and Fechhelm 1998). There are 4 orders, 13 families, and 49 species known for the Gulf of Mexico. Many of these species also occur above 1,000 m. Like mesopelagic fishes, most species are capable of producing and emitting light (bioluminescence) to aid in communicating in an environment devoid of sunlight. Like the mesopelagic fishes, these species display some of the most interesting evolutionary adaptations to the deep-sea environment. Unfortunately, there have been no studies directed at bathypelagic fishes in the Gulf of Mexico.

Demersal Fishes

Demersal fishes are those that are either in direct contact with the substrate or hover above it from the shelf slope transition to the abyssal plain. The taxonomic composition of the demersal ichthyofauna in the Gulf of Mexico includes 27 orders with 70 families representing 300 species (Table 10.3). The most diverse order is the Gadiformes (cod-like fishes) with 7 families and 44 species followed by Anguilliformes (eels) with 5 families and 35 species, Ophidiiformes (brotulas and cusk-eels) with 4 families and 33 species; and Perciformes (perch-like fishes) with 10 families and 28 species.

Representatives of these groups were collected during the MMS-sponsored demersal sampling programs summarized by Pequegnat (1983) and Gallaway et al. (1988). These two programs have provided the most comprehensive data available on the demersal assemblage. The latter program collected samples from eastern, central, and western transects which allowed some spatial comparisons to be made in species composition, density, diversity, food habits and depth-related zonation patterns.

The five most abundant species collected during Pequegnat's sampling program were Gadomus longifilis, Dicrolene intronigra, Synaphobranchus oregoni, Dibranchus atlanticus, and Nezumia aequalis. The top five species collected by Gallaway et al. (1988) were Urophycis cirratus, S. oregoni, Coelorhincus caribbaeus, D. atlanticus, and Bembrops gobiodes. Table 10.4 shows the top species and their depth of maximum occurrence. The numbers of fish per hectare collected on the three transects were 1,222 (western), 620 (central), and 1,511 (eastern). Densities of demersal fishes were estimated from photography as 198.5 fish ha^{-1} during cruises II to V. Densities estimated by trawling were much less than those estimated by benthic photography; some were as high as 12.5 times less. Diversity (Shannon's H') declined with depth along all three transects, but did not differ significantly among the three transects. Some evidence for differing spatial patterns in species composition was provided by sampling along three (eastern, central, and western) downslope transects. A basic finding was that the eastern Gulf supported a more dense and species rich assemblage than the western Gulf (Gallaway et al. 1988).

Table 10.3. Deepwater (>200 m) demersal fishes known from the Gulf of Mexico, arranged in phylogenetic order

Order Myxiniformes	***Order Gadiformes***
Myxinidae (hagfishes)	Bregmacerotidae (codlets)
Order Chimaeriformes	Phycidae (hakes)
Chimaeridae (ratfishes)	Macrouridae (grenadiers)
Rhinochimaeridae (longnose ratfishes)	Merlucciidae (offshore hakes)
Order Orectolobiformes	Steindachneriidae (luminous hake)
Odontaspidae (sand tiger sharks)	Moridae (mores)
Order Carcharhiniformes	***Order Batrachoidiformes***
Scyliorhinidae (catsharks)	Batrachoididae (toadfishes)
Carcharhinidae (requiem sharks)	***Order Lophiiforrnes***
Triakidae (smoothhound sharks)	Antennariidae (frogfishes)
Order Hexanchiformes	Chaunacidae (gapers)
Hexanchidae (sixgill and sevengill sharks)	Ogcocephalidae (batfishes)
Order Squaliformes	Thaumatichthyidae
Echinorhinidae (bramble sharks)	***Order Beryciformes***
Squalidae (dogfish sharks)	Trachichthyidae (slimeheads)
Order Squatiiformes	Berycidae (alfons inos)
Squatinidae (angel sharks)	Holocentridae (squirrelfishes)
Order Torpediniformes	***Order Zeiformes***
Narcinidae (electric rays)	Grammicocephalidae (diamond dories)
Torpedinidae (torpedo rays)	Macrurocyttidae
Order Rajiformes	Parazenidae
Rajidae (skates)	Zeidae (dories)
Order Myliobatiformes	Caproidae (boarfishes)
Dasyatididae (stingrays)	***Order Gasterosteiformes***
Order Notacanthiformes	Centriscidae (snipefishes)
Halosauridae (halosaurs)	Syngnathidae (pipefishes)
Notocanthidae (notacanthid eels)	***Order Scorpaeniformes***
Order Anguilliformes	Scorpaenidae (scorpionfishes)
Synaphobranchidae (cutthroat eels)	Triglidae (sea robins)
Ophichthidae (snake eels)	***Order Perciformes***
Colocongridae	Acromatidae
Congridae (conger eels)	Serranidae (groupers and sea basses)
Nettastomatidae (duckbill eels)	Epigonidae

Serrivomeridae (sawtooth eels)
Order Osmeriformes
Alepocephalidae (smoothheads)
Order Ateleopodoiformes
Ateleopodidae
Order Aulopiformes
Aulopidae (flagfins)
Ipnopinae (tripodfishes)
Synodontidae (lizardfishes)
Order Polymixiiformes
Polymixiidae (beardfishes)
Order Ophidiiformes
Carapidae (pearlfishes)
Ophidiidae (cusk-eels)
Aphyonidae
Bythitidae
Apogonidae (cardinalfishes)
Malacanthidae (tilefishes)
Lutjanidae (snappers)
Zoarcidae (eelpouts)
Uranoscopidae (stargazers)
Percophididae (flatheads)
Callionymidae (dragonets)
Order Pleuronectiformes
Paralichthyidae (flounders)
Bothidae (lefteye flounders)
Cynoglossidae (tonguefishes)
Order Tetraodontiformes
Triacanthodidae (spikefishes)
Monacanthidae (filefshes)

6.7 Crustaceans

6.7.1 *Spiny Lobster*

Spiny lobsters (*Panulirus argus*) are benthic invertebrates that inhabit reefs, rubble, and crevices at depths of 10-80 m or more. They are opportunistic omnivores that forage at night. Adults reach sexual maturity at 3 or more years of age and spawn offshore in deeper reef fringes from April to October. Larvae develop offshore for 8 to 9 months, and as they mature they migrate inshore to seagrass or mangrove habitats (MMS, 1990).

6.7.2 *Blue Crabs and Stone Crabs*

Blue crabs (*Callinectes sapidus*) are opportunistic omnivores and inhabit nearshore benthos with muddy and sandy bottoms and aquatic vegetation. Blue crabs migrate offshore from March to November to mate and then migrate to lower estuary and nearshore waters to spawn. Spawning occurs year round in south Florida waters. Zoeae are transported great distances by currents and develop offshore. During post larval development, megalopae migrate into estuaries (MMS, 1990).

Stone crabs (*Menippe mercenaria*) inhabit areas from shore to 55 m water depths. They are primarily nocturnal carnivores, but also may eat seagrasses. Stone crabs spawn offshore. Upon hatching, plankton develop for 2 to 4 weeks. Principal nursery areas are Florida Bay and Ten Thousand Islands. The principal fishery is located off Collier County, Florida; however, harvesting occurs from Tampa to the Florida Keys and in Apalachee Bay (MMS, 1990).

6.7.3 *Shrimp*

Shrimp are omnivores that feed on detritus, algae, other invertebrates, and zooplankton. Adult shrimp live on a variety of benthic substrates. There are three species of shrimp of importance in the eastern Gulf of Mexico: pink, white, and brown. Pink shrimp predominate off the west/southwest coast of Florida; white shrimp off the coasts of Alabama, Mississippi, and northern Florida; and brown shrimp are most common off the coast of Mississippi. As juveniles, all three species are estuarine dependent.

Pink shrimp (*Penaeus duorarum*) are found along the coast of the Gulf of Mexico with highest concentrations occurring off the southwest Florida coast, and where the shelf is broad and shallow, from the shore to 65 meters. Spawning occurs offshore throughout the year in southern Florida and primarily in summer in northern Florida. Larvae develop offshore, followed by postlarval migration to estuarine waters where juveniles remain for 2 to 6 months (MMS, 1986).

The white shrimp (*P. setiferus*) fishery in the eastern Gulf is concentrated in the north. White shrimp prefer mud or clay bottoms and inland brackish waters of depths less than 35 m. Adults spawn offshore in waters greater than 8 m, with peak spawning occurring in June and July (MMS, 1986).

In the eastern Gulf of Mexico, the brown shrimp fishery is concentrated off the coast of Mississippi. Brown shrimp (*P. aztecus*) occupy depths to 110 m, but are most common between 30-55 m on mud or sandy mud substrates (MMS, 1986). Spawning varies with depth, occurring in two peak periods: October through December and March through May (MMS, 1990). Adults migrate offshore during winter, and return inshore during spring.

6.8 Marine Mammals

Twenty-eight species of marine mammals are known to occur in or migrate through the northern Gulf of Mexico based on sightings and/or strandings (Schmidly, 1981). Cetaceans (whales, dolphins, and porpoises) are the most common. During 1978 to 1987, a total of 1,200 cetacean strandings/sightings were reported for Alabama, Florida and Mississippi to the Southeastern U.S. Marine Strandings Network. Ninety percent of these stranding/sighting occurred off Florida coasts (the Florida figure reflects strandings from both the Gulf and the Atlantic waters; NOAA, 1991). The cetaceans found in the Gulf include species that occur in most major oceans and, for the most part, are eurythermic, with a broad range of temperature tolerances (Schmidly 1981). An introduced species of pinniped, the California sea lion, occurs in small numbers only in the feral condition. All marine mammals are protected under the Marine Mammal Protection Act of 1972.

6.8.1 *Minke Whale*

Minke wales (*Balaenoptera acutorostrata*) are the smallest baleen whales in the northern hemisphere. In the western North Atlantic they occur from the ice pack south to the West Indies and the Gulf of Mexico (Leatherwood and Platter, 1975). They have a general north-south and onshore-offshore trend between summer and winter. Evidence suggests minkes winter offshore south of Florida and the Lesser Antilles, and summer north of Cape Cod. Minke whales are more solitary than other species of baleen whales. Pairing occurs from October to March; gestation is about 10 months and lactation is estimated to be less than 6 months. Diet consists of euphausiids and small fish (Lowery, 1974).

6.8.2 *Pygmy Sperm Whale*

Pygmy sperm whales (*Kogia breviceps*) have a worldwide distribution in warmer seas and tend to be relatively rare. These small whales strand frequently throughout the eastern and northern Gulf of Mexico. Mating takes place in late summer and there is a gestation period of nine months.

Diet consists of squid, crab, shrimp, and some fishes. Pygmy sperm whales appear to occur in small schools of three to six individuals. The Southeastern U.S. Marine Mammal Strandings Network reports the pygmy sperm whale as the second most common singly-stranded species, with an occurrence of 224 strandings/sightings between 1978-1987 (151 of these occurred off Florida coasts; NOAA, 1991).

6.8.3 *Dwarf Sperm Whale*

Dwarf sperm whales (*K. simus*) are very similar in appearance to pygmy sperm whales. Their range, habitat requirements, and diet are very similar, but dwarf sperm whales have been reported more frequently on the Atlantic coast than on the Gulf coast.

6.8.4 *Antillean Beaked Whale*

In the western North Atlantic, the Antillean beaked whale occurs from New York south to Trinidad and the Gulf of Mexico. They are rare in the Gulf, known only from five records, three from Texas and two from Florida. They may inhabit deep waters close to shorelines. Their seasonal movements are unknown. Diet consists primarily of squid (Lowery, 1974).

6.8.5 *Short-Finned Pilot Whale*

Short-finned pilot whales (*Globicephala macrorhynchus*) occur in the tropical and warm temperate regions of the Atlantic, Indian, and Pacific oceans. Their range in the western North Atlantic extends south from Virginia to northern South America and includes the Gulf of Mexico. These whales normally live in deep waters from the continental shelf seaward. They have an extended breeding and calving season and the gestation period is about one year. Diet consists of squid and fish. Short-finned pilot whales are known to occur in groups of 60 or more, but smaller groups are more common (Leatherwood and Platter, 1975). Four events of mass strandings were reported by the Southeastern U.S. Marine Mammal Network between 1978-1987, with 83 individuals being reported off Florida coasts.

6.8.6 *Bottlenose Dolphin*

Bottlenose dolphin (*Tursiops truncatus*) are the most common cetacean in the Gulf of Mexico. They occur in bays, inland waterways, ship channels, and nearshore waters. Apparently, there are two groups of bottlenose dolphins --small discrete populations that inhabit coastal areas, and offshore populations that congregate in large groups. Surveys of the Louisiana/Mississippi coastal waters report about 2,000-6,000 bottlenose dolphins (Leatherwood and Platter, 1975). The Southeastern U.S. Marine Strandings Network reported 531 strandings/sightings for Florida (both east and west Coast) from 1978-1987 (NOAA, 1991). Dolphins usually occur in pods of three to seven animals, but large herds of 200-600 dolphins have been observed. Calving and mating occurs from February to May. Gestation lasts approximately 12 months and lactation up to 18 months. The calving interval is two to three years.

Bottlenose dolphins feed on a variety of fishes, mollusks, and arthropods, apparently selectively choosing the most abundant prey. Leatherwood and Platter (1975) recorded seven recurrent feeding patterns in the northern Gulf: (1) foraging behind working shrimp boats and eating organisms disturbed by the nets; (2) feeding on trashfish dumped from the decks of shrimp boats; (3) feeding on fish attracted to nonworking shrimpers; (4) herding schools of fish by encircling and charging the school, or feeding on the stragglers; (5) sweeping schools of small bait fish into shallow water ahead of a line of dolphins, and charging into the school or feeding on stragglers; (6) crowding small fish into shoals or mud banks at the base of grass flats, driving fish completely out of the water and then sliding onto banks to retrieve them; and (7) individual feeding.

6.8.7 *Striped Dolphin*

The striped dolphin (*Steno ceruleoalba*) is found widely throughout temperate and tropical waters of the world. In the western North Atlantic they prefer warmer, offshore waters and normally are confined to the Gulf Stream or continental slope (Leatherwood and Platter, 1975). With one exception, all records from the Gulf of Mexico are from summer and fall. This may be the result of seasonal movements of the striped dolphin in and out of the Gulf. Diet consists of squid and small fish.

6.9 Birds

6.9.1 *Peregrine Falcons*

The peregine falcon *(Falco peregrinus)* was listed as endangered throughout its habitat. The original eastern United States population of the peregrine, which was extirpated, was considered by most ornithologists to be non-migratory. Cliffs or series of cliffs constituted typical nesting habitat in the eastern United States. However, other forms of nesting habitat have also been utilized, such as river cutbanks, trees, and manmade structures including tall towers and the ledges of tall buildings (FWS, Region 4, 1991).

The principal cause of the peregrine's decline was due to the presence of chlorinated pesticides, especially DDT and its metabolite DDE, which accumulated in peregrines as a result of feeding on contaminated prey. Other less significant factors in the decline include shooting, natural collecting, disease, falconers, human disturbance of nesting sites, and loss of habitat to human encroachment (FWS, Region 4, 1991). The species has recolonized throughout most of its former range. The American peregrine falcon was removed from endangered status in 1999 (MMS, 2000).

6.10 Endangered Species

The USFWS and NMFS evaluate the conditions of species and their populations within the United States. Those species populations considered in danger of extinction are listed as endangered species per the Endangered Species Act of 1973. In addition, Section 7(a)(2) of the Endangered Species Act requires federal agencies to ensure that their action do not jeopardize the continued existence of listed species or destroy or adversely modify critical habitat.

Table 6-2. Federally Listed and Candidate Species in the Eastern Gulf of Mexico [a]

Species	Scientific Name	Federal Listing in Each State[b]		
		Florida	Mississippi	Alabama
Brown pelican	*Pelicanus occidentalis*	---	---	---
Bald eagle	*Haliaeetus leucocephalus*	E	E	E
Piping plover	*Charadrius melodus*	T	T	T
Arctic peregrine falcon[c,d]	*Falco peregrinus tundrius*	T	T	T
American peregrine falcon	*Falco peregrinus anatum*	---	---	E
Wood stork	*Mycteria americana*	E	---	E
Roseate tern	*Sterna dougalli dougalli*	T	---	---
Cape Sable sparrow	*Ammodramus maritima*	E, CH	---	---
American crocodile	*Crocodylus acutus*	E, CH	---	---
Loggerhead sea turtle	*Caretta caretta*	T	T	T
Kemp's ridley sea turtle	*Lepidochelys kempii*	E	E	E
Green sea turtle	*Chelonia mydas*	E	T	T
Hawksbill sea turtle	*Eretmochelys imbricata*	E	E	E
Leatherback sea turtle	*Dermochelys coriacea*	E	---	E
Florida manatee	*Trichechus manatus latirostris*	E, CH	---	E
Finback whale	*Balaenoptera physalus*	E	E	E
Humpback whale	*Megaptera novaeangliae*	E	E	E
Right whale	*Eubaleana glacialis*	E	E	E
Blue whale	*Balaenoptera musculus*	E	E	E
Sei whale	*Balaenoptera borealis*	E	E	E
Sperm whale	*Physeter macrocephalus*	E	E	E
Choctawhatchee beach mouse	*Peromyscus polionotus allophrys*	E, CH	---	---
Alabama beach mouse	*Peromyscus polionotus ammobates*	---	---	E, CH
Perdido Key beach mouse	*Peromyscus polionotus trissyllepsis*	E, CH	---	E, CH
Key Largo cotton mouse	*Peromyscus gosssypinus allapaticola*	E	---	---
Florida panther[d]	*Felis concolor coryi*	E	E	E
Key Largo woodrat[d]	*Neotoma floridana smalli*	E	---	---
Lower Keys rabbit[d]	*Sylvilagus palustris hefneri*	E	---	---
Gulf sturgeon	*Acipenser oxyrhinchus desotoi*	T	T	T
Southeastern snowy plover[d]	*Charadrius alexandrinus tenuirostris*	C	C	C
St. Andrew beach mouse	*Peromyscus polionotus peninsularis*	C	---	---
Santa Rosa beach mouse	*Peromyscus polionotus leucocephalus*	C	---	---

[a] Sources: Carmody, 1993; Stevens, 1993.
[b] E=Endangered; T=Threatened; CH=Critical Habitat; ---=Not listed for that State; C=Candidate
[c] The arctic peregrine falcon was delisted from the endangered species list October 5, 1994 (50 FR 50796-805).

6.10.1 *Endangered Marine Mammals*

The Florida manatee, five baleen whales (the northern right, sei, fin, humpback, and blue), and one toothed whale (sperm) are endangered marine mammals in the Gulf of Mexico. The sei, fin, and humpback whales are eurythermic, with a broad range of temperature tolerances and are found in most major oceans (Schmidly, 1981). The right whales have a distinct bipolar distribution and are regarded as cold-stenothermal (Schmidly, 1981). The sperm whale is common in the Gulf, whole the baleen whales are considered uncommon (Davis and Fargion, 1996 in MMS, 2000).

Florida Manatee

The Florida manatee (*Trichechus manatus latirostris*) is a subspecies of the West Indian manatee and is endangered in Florida and Mississippi. It is a massive, fusiform, thick skinned, aquatic mammal with paddle-like forelimbs, no hindlimbs, and a spatulate, horizontally flattened tail. The diet of the manatee consists of submergent, emergent, and floating plants, limiting their habitat to low-energy, inshore areas that support seagrass growth.. Florida manatees are found in the southeastern U.S., ranging as far west as Louisiana in the Gulf of Mexico and as far north as the Carolinas and Chesapeake Bay in coastal and riverine waters off the Atlantic (MMS, 2000).

Adults range in color from gray to brown, while calves are darker at birth and change to a grayish color by about one month. The average length of a manatee is about 3 meters (9.8 ft.) and the average weight is 360-540 kilograms (793-1190 pounds; Van Meter, 1989). Females may be bigger and heavier than males.

The exact number of Florida manatees is unknown, but winter aerial surveys at warm-water refuges in 1985 counted a minimum of 800-1,200 animals (USFWS, 1989), of which 9 to 13 percent were calves (Van Meter, 1989). These figures may reflect a tendency for females with calves to seek out warm-water refuges more than other adults. It is unknown if the birthrate is high enough to offset the 120 or so dead manatees recovered annually in Florida in recent years (Van Meter, 1989).

The following areas are designated as critical habitat for the manatee on the Gulf coast of Florida (USFWS, 1990).

- Crystal River and its head waters
- Kings Bay in Citrus County
- Little Manatee River in Hillsborough County
- Myakka River in Sarasota and Charlotte Counties
- Charlotte Harbor in Charlotte County
- Caloosahatchee River in Lee County
- U.S. territorial waters adjoining coasts and islands in Lee County
- U.S. territorial waters adjoining coasts and island and all connecting bays, estuaries, and rivers from Gordon's Pass in Collier County to Whitewater Bay, Monroe County
- All waters of Card, Barnes, Blackwater, Little Blackwater, Manatee, and Buttonwood Sounds between Key Largo in Monroe County

Decline of the manatee is attributed to overfishing of the species for its meat, oil, and leather. Currently, cold stress, calf mortality, and human disturbance also are threats to the manatee.

Right Whale

The right whale (*Eubaleana glacialis*) is listed as endangered by USFWS. The range of the western North Atlantic population is from Iceland to Florida and the Gulf of Mexico. This population estimated to be 250 to 350 individuals; the Gulf of Mexico population is unknown.

Historical observations of right whales in the eastern Gulf of Mexico include a two sightings off Manatee and Sarasota counties in Florida (MMS, 1990; 2000); and a stranding in Texas (Schmidly et al., 1972 in MMS, 2000). The right whale is not a normal inhabitant of the Gulf; they migrate northward along the eastern Florida coast between January and March and have been observed in the Gulf of Mexico during this time. The southward migration occurs in fall farther offshore. Mating takes place in the North Atlantic in late summer. Gestation is assumed to be one year, with calves suckling for approximately one year. Right whales feed by "skimming" at or below the surface for copepods and euphasids.

Sei Whale

Sei whales (*Balaenoptera borealis*) occur in all oceans and are listed as endangered. Sei whales are widely distributed in the nearshore and offshore waters of the western North Atlantic but are rare in tropical and polar areas. A sei whale was reported in 1973 off Gulfport, Mississippi (MMS, 1990); one stranding on the Florida Panhandle; and three or four strandings in eastern Louisiana (Jefferson and Schiro, 1997). Little information is available on their seasonal movements. In the North Atlantic, their diet consists primarily of copepods, although they take euphasids and small schooling fish. Sei whales usually travel in groups of two to five individuals but may concentrate in larger numbers in their feeding grounds (Leatherwood et al., 1976). During an eleven month aerial survey from July 1989 until June 1990, Mullin et al. (1991) may have sighted only one sei whale in De Soto Canyon off the coast of Mississippi.

Fin Whale

Fin whales (*Balaenoptera physalus*) are listed as endangered by NMFS. They occur from Greenland in the western North Atlantic, to the Gulf of Mexico and the Caribbean (Leatherwood et al., 1976). Fin whales are most often sighted where deep water approaches the coast (Jefferson et al., 1993 in MMS, 2000). Their diet consists mainly of krill, squid, and small fish (Lowery, 1974). Fin whales have been stranded in all regions of the Gulf throughout the year (Caldwell and Caldwell, 1973); there have been seven reports of fin whales in the Gulf indicating that they are not abundant in that region. During an eleven month aerial survey, only one fin whale was sighted in the De Soto Canyon area in November 1989 (Mullin et. al., 1991).

Humpback Whale

Humpback whales (*Megaptera novaeangliae*) have been listed as endangered since 1970 after a great reduction in number from commercial whaling (Marine Mammal Commission, 1988). Historically, the species has been threatened by commercial vessel traffic, commercial fisheries, coastal development, and more recently, whale-watching tour boats. They inhabit most of the world's oceans with only rare sightings in the eastern and central Gulf of Mexico. North Atlantic populations breed and calve during the winter months.

In 1962 and 1983, humpback whales were sighted near the mouth of Tampa Bay and in 1983 near Seashore Key, Florida (MMS, 1990). Historically, they were sighted in the northern Gulf waters; one whale in 1980 in coastal waters off Pensacola (Weller et al., 1996), six whales in May 1998 in deep water of DeSoto Canyon (Ortega, personal communication, 1998 in MMS, 2000), and two possible sightings in 1952 and 1957 off the Alabama coast (Weller et al., 1996). Most recently, a stranded dead humpback was found on the beach east of Destin, Florida in April 1998 (Mullin, personal communication, 1998 in MMS, 2000).

Blue Whale

Blue whales (*Balaenoptera musculus*) are listed as endangered. They occur in all oceans of the world yet have only been sighted in the Gulf, both times as strandings in Texas (Lowery, 1974 in MMS, 2000). Migratory blue whales move toward the poles in spring and summer and to subtropical and tropical waters for winter (Yochem and Leatherwood, 1985 in MMS, 2000). Blue whales are the largest animals known and feed mainly on zooplankton.

Sperm Whale

Sperm whales (*Physeter catodon*) also are endangered. Their diet consist mainly of mesopelagic squid, but also include other cephalopods, demersal fish, and benthic invertebrates (Rice, 1989 in MMS, 2000). They occur in all of the world's oceans, limited to deeper waters along the edge of the continental shelf, and are rarely found on the shelf itself. In spring, bull sperm whales join female nursery schools and form "harems." Mating occurs in spring during the migration north. Gestation lasts 14 to 16 months with a 1- to 2-year lactation period.

In the past, sperm whales were numerous enough in the Gulf of Mexico to justify full-scale whaling operations. This fact, and relatively common sightings, suggest there may be a separate population in the Gulf (Fritts et al., 1983). Congregations of sperm whales are commonly seen off the shelf edge of the Mississippi River Delta (MMS, 2000). In the northern Gulf of Mexico, sperm whales are present throughout the year.

6.10.2 *Endangered Birds*

Brown Pelican

The brown pelican (*Pelecanus occidentalis*) was taken off the endangered species list in Alabama in 1985 and is not Federally listed as endangered in Florida. However, Florida has designated it as a species of special concern. The brown pelican is a species of colonial bird that nests on small coastal islands in salt and brackish waters. They are rarely found more than 20 miles from land. Their diet consists primarily of fish, including menhaden, mullet, sardines, and pinfish. The decline of the brown pelican was attributed to their ingestion of pesticides (USFWS, 1991). They are also highly susceptible to abandoning their nests once disturbed (USFWS, 1991). In 1985 the brown pelicans and their habitat in Alabama, Florida, Georgia, the Carolinas, and points northward on the Atlantic coast were removed from the endangered list. In the Gulf of Mexico, however, the brown pelican is still listed as endangered in portions of Louisiana and Mississippi (MMS, 2000).

A comprehensive recovery plan was completed in 1979, and revised in 1987. The primary objective of the plan is to restore a self-sustaining population of peregrine falcons in the eastern United States. A captive breeding program was initiated by the Peregrine Fund at Cornell University beginning with the 1971 breeding season. As of 1990, approximately 1,178 falcons had been released in 11 northeastern states (FWS, Region 4, 1991).

Bald Eagle

Bald eagles (*Haliaeetus leucocephalus*) are listed as threatened in the 48 contiguous states. Their nesting habitats are along major lakes and rivers throughout the southeastern coastal plain, from the Chesapeake Bay to the Florida Keys, and north along the west coast of Florida to the panhandle, through Louisiana and into Texas. Bald eagles mate for life; pairs begin nest building in early fall and lay eggs in October. Nesting populations are gradually increasing in most areas of the country (USFWS, 1987a). The endangered bald eagles feed primarily on fish, but, as opportunistic feeders, also feed on waterfowl and shorebirds, particularly sick or injured individuals and carrion (USFWS, 1991).

A survey from 1973 to 1988 in Florida showed reproduction to be successful. The highest reproductive year was 1988 when 448 young were born from 399 occupied breeding areas (USFWS, 1990). Most of the breeding occurs in the west coast counties. Each county on the Gulf, except Dixie and Jefferson Counties, fosters active bald eagle nests (USFWS, 1990).

An area of concentrated nesting or "essential habit" is viewed as a nuclear population and is considered important for long-term survival of the species. In Florida, population centers are found in Charlotte County along portions of the western Charlotte Harbor coast east of State Road 771 and adjacent to Gasparilla Sound; and in Lee County in areas adjacent to San Carlos Bay, Matlacha Pass south of State Road 78, Matanzas Pass, and Estero Bay (USFWS, 1990). *NEEDS UPDATE*

Piping Plover

The piping plover (*Charadrius melodus*) is listed as threatened in Florida, Mississippi, and Alabama. The estimated world population was 4,000 birds in 1993. The piping plover frequents unvegetated open sand areas where it feeds mainly on surface and infaunal invertebrates. The extensive sand flats of Laguna Madre and other barrier islands are important habitats. This bird has three primary breeding areas: the Great Lakes, the midwest prairies, and the North Atlantic coast. During winter, piping plovers inhabit the beaches, sandflats, and dunes of the Atlantic and Gulf Coast, from North Carolina to Mexico. Intercoastal spoil islands also are used.

Loss of appropriate beaches and other littoral habitats for the piping plover is due to recreation, coastal development, and dune stabilization. The species' preferred breeding habitat is often disturbed by humans (USFWS, 1990). In July 2000, 146 areas along the Atlantic coast from the Carolinas, continuing along the entire Florida coast and throughout the Gulf of Mexico were proposed as critical habitat for wintering populations (MMS, 2000).

Wood Stork

The wood stork (*Mycteria americana*) is endangered in Florida and Mississippi. Breeding in the United States takes place only in Florida, Georgia, and minimally in South Carolina (USFWS, 1990). After breeding the storks move northward, as far as Arkansas in the Mississippi River Valley, and into North Carolina, along the Atlantic Coast. The population is estimated to be approximately 10,000 adults (USFWS, 1990).

In Florida, wood storks are known to nest from Leon to Duval Counties, south to Everglades National Park (USFWS, 1990). Storks have been sighted in Alabama in Bon Secour, St. Vincent Island, St. Marks, and Lower Suwannee refuges (USFWS, 1990).

Man's alteration of wetlands is the cause of the decline of the wood stork. The storks' feeding habits require a high concentration of prey. Optimal feeding ground for the stork is that which alternates periods of flooding with periods of dry. During the flooding periods the fish swim into the storks' habitat and are then trapped and concentrated by nature during the dry periods. The dry period coincides with the stork's breeding season. This would provide the stork with an ample food supply for the offspring. However, loss of cypress swamps in Florida, which are appropriate feeding grounds, is a factor in the decline of the wood stork (USFWS, 1990). *NEEDS UPDATE*

Roseate Tern

The roseate tern (*Sterna dougalli dougalli*) is listed as threatened in Alabama and Florida. The roseate tern nests from Nova Scotia to Virginia and in the Florida Keys, Bahamas, eastern West Indies, and along the coast of South America from the Guianas to Brazil. These birds are ocean feeders that pluck fish from waters adjacent to their breeding grounds. As the young mature, they travel farther from shore to look for food (USFWS, 1990).

In the Florida Keys there are two colonies of roseate terns; there have been only rare sightings in the Florida Panhandle. There is one colony of 225 terns on a low lying island near the reef line off Key West (USFWS, 1990). In 1988, this colony was located on Tank Island (USFWS, 1990). The eggs from this colony were examined after two nesting failures. This examination revealed the presence of *Escherichia coli* and *Pseudomonas* species. This is believed to be caused by the sewage outfall from Key West. The second colony is located on the roof of a condominium complex in the middle of the Keys. These colonies can be disturbed by humans, pollution, and tropical storms. It is believed that these colonies have not declined significantly in the past ten years (USFWS, 1990).

Cape Sable Sparrow

The Cape Sable sparrow (*Ammodramus maritima*) has been listed as endangered since March 11, 1967 (USFWS, 1990). It has an olive-gray body with an olive-brown tail and wings, light grey with dark olive grey streaks on the breast and the sides, and gray legs, ear patch, and bill. It has brown eyes and a white throat (Werner, 1979). The Cape Sable sparrow inhabits interior, fresh to brackish marshes in extreme southern and southwestern Florida. At one time, their range extended east of the mangrove zone from Carnstown to Shark Valley Slough (Werner, 1979). Currently, they are only occasionally sighted in this area. The sparrow prefers cordgrass broken by patches of spike rush, salt grass, and small ponds. It is highly adapted to a fire environment (Werner, 1979).

The Cape Sable seaside sparrow is listed as endangered due to its restricted distribution and specific habitat requirements. A 1985 survey indicated that the population has not decreased since 1981 (O'Meara and Marion, 1985).

Cape Sable sparrows are territorial, and except during breeding season, they are secretive (Werner, 1979). The nest is suspended and hidden in a tuft of grass, and is woven out of fine grasses in the shape of a dome or cup. They nest between February and August, laying 3 to 4 eggs in a clutch. Some lay as many as 3 clutches a season and eggs are incubated at least 11 days. The breeding season seems to correspond with the hydroperiods of the marsh, with nesting decreasing during the flood periods. The young stay in the nest for 9 to 11 days and are capable of short flights after 2½ weeks (Werner, 1979). They feed on insects and flowers (Werner, 1979). *NEEDS UPDATE*

6.10.3 *Endangered Reptiles*

Five endangered marine turtles and the American Crocodile inhabit Gulf of Mexico waters. The marine turtles are strongly adapted to aquatic life, mating at sea and only visiting dry land to lay their eggs. Most of the sea turtles of the United States nest in Florida, from Sarasota to Boca Grande and in the Cape Sable Region (Van Meter, 1990). The eggs are buried in the duneline above mean high tide, where they are preyed upon by man, raccoons, dogs, cats, rats, feral pigs, foxes, crabs, lizards, and insects. The eggs incubate 50 to 70 days before hatching. Hatchlings immediately enter the water where they are preyed upon by gulls, crows, raccoons, dogs, cats, etc. The first few years of their lives are spent in pelagic waters, mainly in driftlines and convergence zones (in sargassum rafts) where food and refuge are present (Carr, 1986; 1987 in MMS, 2000).

Adult turtles in the Gulf of Mexico mainly occur in waters less than 27 - 50 m deep (NRC, 1990 in MMS, 2000). Predators of adult sea turtles include man, crocodiles, large fish (groupers), killer whales, and sharks (Mager, 1985).

Green Sea Turtle

The green sea turtle (*Chelonia mydas*) is found throughout the world in tropical and semi-tropical waters. Green turtles are believed to be long-lived (20 years or longer), but longevity rates in the wild are uncertain (Hirth, 1971). Ehrenfeld (1974) estimated that the total world population of sexually mature green turtles was no more than 100,000 to 400,000, while Caribbean stocks alone may have amounted to 50 million in the 17th century.

Primary breeding grounds in North America are on the southern Florida Atlantic beaches. It is estimated that 375 green turtles nest in Florida, with 400 to 800 nests being reported each year. Nesting is primarily reported between May and August and occurs only on Florida beaches and along the Yucatan Peninsula (Rabalais, 1987). In the eastern Gulf, six nests were reported in Monroe County, Florida, on East, Marquesas, Woman, and Boca Grande Keys. Recently, nests have been recorded on the northwest coast of Florida--in 1987 on Eglin Air Force Base, and in 1989 on Navarre Beach and on Santa Rosa Island (USFWS, 1990).

Females deposit between 3 and 7 clutches per season at intervals of 10 to 18 days. Average clutch size varies between 80 and 150 eggs that hatch within 48 to 72 days. Hatchlings emerge, usually nocturnally, and travel quickly to water to spend a year in a so-called "swimming frenzy" before they graduate to adult diving behavior farther out to sea (Mager, 1985).

Juvenile green turtles are common in the lagoons and bays along the Florida and Texas coasts. Juvenile greens frequently spend daylight hours in inshore waters, venturing out to the open sea at night. The upper west coast of Florida is a principal feeding ground for green turtles, where they forage on seagrasses, algae, and associated organisms (MMS, 2000). Observations indicate that they enter inlets during the summer months and feed on the copious supplies of turtle grass (*Thalassia testudinum*), shoal grass (*Halodule wrightі*), widgeon grass (*Ruppia maritima*), and other plant life, algae, and small invertebrates that exist in these locations (Raymond, 1985). Important feeding areas include Indian River, Florida Bay, Homosassa River, Crystal River, and Cedar Key (NMFS, 199a in MMS, 2000).

Since breeding and nesting grounds tend to be far from forage areas, the green turtle frequently migrates very long distances, and tagged females rarely appear in the same nesting area twice. Along the east coast of the U.S., adult green turtles are found from Massachusetts to the Gulf of Mexico.

The turtle's survival in Florida is threatened by beach lighting, habitat alterations, and drowning in fishing gear (Van Meter, 1990). Many of Florida's green turtles have tumorous warts on their bodies called fibropapillomas thought to be viral in origin. Some die, while others recover from this disease. They were first reported in 1982 on a green turtle in the Indian River where large numbers of immature green turtles in the lagoon system were discovered to be afflicted by the disease (Mager, 1985).

Hawksbill Sea Turtle

The hawksbill sea turtle (*Eretmochelys imbricata*) is endangered in Mississippi, Florida, and Alabama. No reliable estimates are available on hawksbill populations. Nesting sites within the U.S. are limited to southeastern Florida and the keys. Preferred nesting sites are on clean, gravelly-textured beaches with significant oceanic exposure and little activity that would disturb nesting. Hawksbill sea turtles are rarely seen in the Gulf. The species is more agile than other sea turtles and can climb over rocks, vegetation, and other obstructions to find its preferred nesting area among the thick vegetation at the rear of the beach platform (Mager, 1985). Females nest alone very quickly. They typically nest in two to three-year cycles and deposit one to four clutches at 15 to 19 day intervals. Hatchlings emerge at night and head directly to the sea where they are pelagic for some time.

Hildebrand (1987) studied the movements of hawksbill hatchlings based on the pattern of the IXTOC oil spill, which occurred offshore from their nesting site. He concluded that they were propelled northward in warm months by their neonatal "swimming frenzy." During the colder months they return south; Hildebrand surmised that the pelagic young use sargassum or *Trichodesmium* for cover, at this time.

At a later age, the hawksbill becomes a benthic feeder. It inhabits reefs, shallow coastal areas, rocky areas, and passes and is generally found in waters less than 20 meters deep. The hawksbill is omnivorous. Although it prefers sponge, its diet consists of algae, seagrasses, soft corals, crustaceans, mollusks, sponges, jellyfish, and sea urchins.

Leatherback Sea Turtle

The leatherback sea turtle (*Dermochelys coriacea*) is the largest of the sea turtles. Belonging to the family dermochelyidae, it is distinct from the other sea turtles in the Gulf. The main anatomical difference is, as its name suggests, the lack of a real shell, and instead it is covered by a thick, leather-like skin. The leatherback is the most oceanic of all sea turtles and ranges in the Pacific, Atlantic, and Indian Oceans. It ranges farther north than other turtles, as far as Labrador and Alaska, probably because of its ability to maintain warmer body temperatures over longer periods of time. Although it was once thought that males, juveniles, and hatchlings stay mainly in deep waters, they have been sighted in the shallow waters of the Gulfs of Maine and Mexico, including both the east and west coasts of Florida. The primary Gulf habitat of the leatherback is waters greater than 200 m deep; the region from Mississippi Canyon east to DeSoto Canyon appears to be an important area (Davis and Fargion, 1996 in MMM, 2000). Leatherbacks have been sighted in the Destin Dome region (MMS, 2000).

The leatherback's diet consists of tunicates and jellyfish. In the Gulf of Mexico, its primary prey is the jellyfish, *Stomalophus melagris* (Rabalais, 1987). The number of nesting females is estimated to be as high as 120,000 (Pritchard, 1983) and as low as 70,000 (Mrosovsky, 1983) worldwide. In the Gulf of Mexico, nesting most often occurs along the coast of Mexico. The interval between nestings in one season is 7 to 13 days with clutch sizes varying between 50 and 160 eggs that hatch in 60 to 70 days. Most of the females tagged while nesting are never seen again (Hughes, 1982). Sightings of leatherbacks are common on the Gulf coast of Florida in March and April, although nesting attempts have been rare.

Loggerhead Sea Turtle

Loggerhead turtles (*Caretta caretta*) are threatened in Mississippi, Florida, and Alabama. They are the most abundant of the marine turtles found in the northern Gulf, concentrated primarily toward the Florida coast. Survival in Florida is threatened by habitat loss and drowning in shrimp trawls.

Loggerhead turtles frequent the temperate waters of the continental shelf along the Atlantic and Gulf of Mexico, foraging around rocky places, offshore oil platforms, coral reefs, and shellfish beds (Raymond, 1985). They have been observed as far as 500 miles out in open sea and in the bays and estuaries of Texas. Rabalais (1987) postulated that they migrate north each year with the shrimp fleet from the Rio Grande. Hildebrand (1987) confirmed that loggerheads and shrimp apparently have similar seasonal migration patterns.

In the southeastern U.S., an estimated 14,000 females nest each year. In Florida, they nest from late April to September (Van Meter, 1990). Loggerheads nest on various barrier islands and beaches from the Florida Keys up the coast of Florida, north to Georgia and South Carolina, and west to the Chandeleur Islands off Louisiana (where most of the nesting occurs). The Florida Panhandle, especially Gulf, Franklin, and Bay counties, account for approximately one-third of Florida Gulf coast nesting. Nesting also occurs in Alabama, Mississippi, Louisiana, and Texas.

Females nest generally at night, depositing an average of 120 eggs which hatch in approximately 60 days. Females typically nest four to five times per season. Loggerheads will disperse to feeding grounds after nesting; these feeding grounds range as far north as New Jersey (in warmer months) to the Florida Keys, and throughout the Gulf of Mexico, the Bahamas, and the Dominican Republic (Van Meter, 1990). Hatchlings enter the sea immediately and may spend the early part of their lives associated with mats of sargassum weed and other flotsam (Pritchard, 1979). Surveys have found loggerheads mainly in water depths less than 100 m, throughout the Northern Gulf continental shelf, and frequently in the Destin Dome area (MMS, 2000). Loggerheads are omnivorous, feeding on shellfish, crabs, hermit crabs, barnacles, oysters, conchs, sponges, jellyfish, squid, sea urchins and sometimes fish, algae, and seaweed (NMFS, 1987).

Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle (*Lepidochelys kempi*) is the smallest of the sea turtles and is the most endangered. It is not known how many years are required to reach sexual maturity. The previously assumed onset of maturity at 6 to 8 years has been reassessed to perhaps 15 years (Woody, 1986). Population size estimates vary, but the Kemp's ridley nesting population is believed to be approximately 1,500 females (Byles et al, 1996 in MMS, 2000). Currently, it is still threatened by shrimp trawl drowning, habitat alterations, and pollution.

The Kemp's ridley has the most restricted range of the five species found in the Gulf, with the greatest concentrations of mature Kemp's ridleys being in the shallow coastal areas of Louisiana and the Tabasco-Campeche area of Mexico (Raymond, 1985). All ages are common off Big Gulley, east of Mobile Bay offing, Alabama (MMS, 2000). Young Kemp's ridleys are known to occur in U.S. coastal waters from Florida to the Gulf of Maine, leading to the speculation that they migrate north passively along the course of the Gulf Stream. By the time they reach the New England shoreline, they are large enough for active swimming. At this age, they head south to the Gulf of Mexico (NMFS, 1987).

There is only one key nesting area, an isolated stretch of beach no more than 15 miles long, in the Mexican state of Tamaulipas near the village of Rancho Nuevo. Only 300 to 350 females nest each year between April and June (Van Meter, 1990). Isolated females have nested on Padre Island National Seashore and other locations in the western Gulf. The Kemp's ridley is the only sea turtle to routinely nest during daylight hours. Nesting occurs during periods of strong wind, possibly because the wind will cover the tracks and nest sites. There are two documented cases of Kemp's ridley sea turtles nesting in Florida; one in May, 1989, at Madeira Beach in Pinellas County and a second on Clearwater Beach in 1994 (Johnson, personal communication, 1994 in MMS, 2000). The result of 116 eggs laid at Madeira Beach was 24 hatchlings (USFWS, 1990).

The diet of the Kemp's ridley sea turtle consists mostly of various species of crabs (e.g., *Ovalipes, Callinectes*) but includes crustaceans, jellyfish, mollusks, fish, gastropods, and echinoderms. Hatchlings are omnivorous, becoming more carnivorous as they become larger and more mobile.

Because of the alarming decline in the Kemp's ridley population, the Mexican Fisheries Department, USFWS, the NMFS, and the National Park Service reached an agreement in 1978 to cooperate in a 10-year program designed to establish nesting sites in the United States. Eggs are collected in Mexico and transported to artificial nests at Padre Island National Seashore. During 1997, nine nests were confirmed on the Texas coast (Shaver, personal communication, 1997 in MMS, 2000).

6.10.4 *Endangered Mammals*

Key Deer

The key deer is endangered in Florida. It ranges from Big Pine Key to Sugarloaf Key. The current population is estimated at 250 to 300 individuals (USFWS, 1990). In 1978, the population was estimated at 400 deer. The key deer inhabit only those islands with a permanent freshwater supply. Most of the population are found on Big Pine Key and No Name Key. Key deer move between the larger keys and the outlying smaller keys. This movement is believed to depend on the availability of a freshwater supply (USFWS, 1990). Habitat destruction and human disturbances are mostly responsible for the decline of this species; other causes include road kills, falling into drainage ditches, feral dogs and pigs, and illegal feeding.

Florida Saltmarsh Vole

The Florida saltmarsh vole (*Microtus pennsylvanicus dukecampbelli*) is endangered in Florida. The population is located in a tidal salt marsh on Waccasassa Bay on the Gulf coast of Florida (Woods et al., 1982). The subspecies was discovered in 1979 (Smith, 1990). The vole's diet is believed to consist of seeds and parts of succulent plants, although it also may include insects, snails and crabs, and possibly sparrow and wren eggs (Smith, 1990).

Predators include other salt marsh rodents (e.g., voles, marsh rats, cotton rats, and cotton mice), marsh hawks, short-eared owls, and raccoons (Smith, 1990). The vole species *M. pennsylvanicus* demonstrates extraordinary swimming, diving, and climbing abilities (Smith, 1990). Their nests are found above the high water line. These factors contribute this species' survival in the harsh environment of the salt marsh.

Natural forces, especially tropical storms, are the biggest threat to such a small population. Hurricane Elena of 1983 "inspired" Smith's trapping survey which yielded only one trapped male

Florida salt marsh vole. It is believed that other populations may exist; however, they may be so small that they are hard to detect (Smith, 1990).

Choctawatchee Beach Mouse
Perdido Key Beach Mouse
Alabama Beach Mouse

The Choctawatchee beach mouse (*Peromyscus polionotus ammobates*) and Perdido Key beach mouse (*Peromyscus polionotus trisyllepsis*) are endangered in Florida. The Alabama Beach Mouse (*Peromyscus polionotus allophrys*) is endangered in Florida and Alabama. The mice are nocturnal herbivores that inhabit primary and secondary dunes and scrub dunes along the Gulf. They eat the seeds of beach grass (*Paicum amarum* and *P. repens*) and sea oats (*Uniola paniculata*). They dig burrows into the lee side of sand dunes and are known to utilize ghost crab (*Ocypeda quadratus*) burrows. Loss of habitat due to tropical storms is the most important cause for the decline of these beach mice (USFWS, 1990).

The Choctawatchee beach mouse is located in three Florida areas: 7.9 km of beach around Morrison Lake to Stalworth Lake, Walton County; Shell Island at St. Andrew Bay in Bay County; and Grayton Beach State Park. The Grayton Beach population was relocated from Shell Island and bred at Auburn University. All of these areas plus part of St. Andrews State Recreation Area in Bay County have been designated as critical habitat (USFWS, 1990).

In 1986, the only known population of the Perdido Key beach mouse was located at Gulf State Park, Alabama. Through a cooperative effort between the state and Federal government, the species has been reintroduced to Gulf National Seashore on Perdido Key by translocating individuals from Gulf State Park. Critical habitat has been designated in Gulf State Park, Baldwin County, Alabama, and Perdido Key State Recreation Area and Perdido Key Unit of Gulf Islands National Seashore, Escambia County, Florida (USFWS, 1990; 1991).

The Alabama beach mouse ranges from Fort Morgan State Park to the Romar Beach Area, but has disappeared from most of this range (USFWS, 1990). Fort Morgan and Bon Secour State Park National Wildlife Refuge, and part of the Gulf State Park in Baldwin County, Alabama, have been designated as critical habitat (USFWS, 1990; 1991).

St. Andrew Beach Mouse
Santa Rosa Beach Mouse

The St. Andrew beach mouse (*Peromyscus polionotus peninsularis*) and Santa Rosa beach mouse (*Peromyscus polionotus leucocephalus*) are listed as Category 2 candidate species in Florida. Not enough information is currently available to propose them as being threatened or endangered (Carmody, 1991). These beach mice hold similar niches as the Choctawatchee, Perdido Key, and St. Alabama beach mice.

Two unstable populations of the St. Andrews beach mouse occur on the mainland portion of Tyndall Air Force Base, Bay County, and on Cape San Blas on St. Joseph State Park, Gulf County. A stable population of the Santa Rosa beach mouse occurs on the undeveloped portion of Santa Rosa Island and on the Gulf Islands National Seashore (USFWS, 1990).

6.10.5 *Endangered Fishes*

Gulf of Mexico Sturgeon

The Gulf of Mexico sturgeon (*Acipenser oxyrhynchus desotoi*) is a threatened species in Florida, Mississippi, and Alabama. The sturgeon occurs in the marine waters of the central and eastern Gulf of Mexico south to Florida Bay, and in most major rivers, from the Mississippi River to the Suwannee River. According to an analysis by Wirgin and Waldman, there are significant differences in the DNA of six geographically disjunct populations in the Gulf of Mexico (Patrick, 1993).

Overfishing, water pollution, and damming of rivers are attributed with the near disappearance of sturgeon at the turn of the century (USFWS, 1991). The most abundant population of the Gulf of Mexico sturgeon is in the Suwannee River, where population estimates ranged from 60 to 282 fish, between 1983 and 1988 (USFWS, 1991).

Gulf of Mexico sturgeon are anadromous fish, migrating between fresh water and saltwater. The sturgeon begin their upriver migrations when river temperatures increase to 16°-23°C (60.8°-75°F), the migration continues until early May. They begin their downriver migration in late September and October when the river temperature decreases to about 19°C (66.2°F). They return to the estuaries of the Gulf of Mexico by mid-November and early December (Patrick, 1993). Young sturgeon remain at the river mouths and do not travel far into the Gulf of Mexico. There have been no reported catches of Gulf of Mexico sturgeon in Federal waters (USFWS, 1991). This information is a result of ultrasonic and radiotelemetry tagging studies in the Apalachicola and Suwannee Rivers; these rivers are still being monitored. The tagging studies also found high probability of recapturing fish in the same river in which they were originally tagged, suggesting that sturgeon return to the same area each summer (Patrick, 1993).

Little is known about the Gulf of Mexico sturgeon reproduction in the wild. Sexual maturity is believed to occur between the ages of 7 to 21 years for females and 8 to 17 years for males. Optimal spawning habitat probably includes river springs and rocky substrate (Patrick, 1993).

There is little information about the predators and competitors of sturgeon. Sturgeon seem to be protected from predators due to their protective plates and secretive nature, although other species may prey on sturgeon eggs. Other benthic organisms, especially fish may also compete with the sturgeon for space and food (Patrick, 1993).

Stomach content analyses indicate that sturgeon may prefer hard bottom, sandy bottom, and sea grass community habitats (USFWS, 1991). No studies have been performed to delineate their exact marine habitat preference, but this stomach content analysis may explain why their range does not include the western Gulf, where the substrate is muddy (USFWS, 1991). Stomach content analyses also indicate that the most important food organism for the Gulf of Mexico sturgeon are amphipods. Other prey include isopods, midge larvae, polychaetes, oligochaetes, lancelets, brachiopods and some unidentifiable vegetable or animal matter (Patrick, 1993). Sturgeon feed while in marine waters for three or four months, but do not feed while in the river for eight or nine months (Patrick, 1993). This trend coincides with growth studies that indicate that weight is only gained during the three or four winter and spring months spent in the estuary and is lost in the eight or nine months spent in the river (Patrick, 1993).